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THE NORMAL AND PATHOLOGIC ANATOMY OF THE SELLA TURCICA AS REVEALED AT NECROPSY [1]

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THE roentgenologic interpretation and significance of changes in and about the sella turcica are so dependent on an accurate knowledge of the normal and pathologic anatomy of this structure that this study was undertaken in an effort to demonstrate in a series of 110 cases the normal and pathologic changes found postmortem. As the roentgen image of the sella is dependent on the configuration of the sphenoid bone, dorsum sellæ, and clinoid processes, observation was limited to the variations found in these structures. The sella and surrounding processes were removed *in toto* and the soft tissues dissected from the bone.

Variations in Size

The dimensions of the sella turcica in normal specimens were measured in the antero-posterior, vertical, and transverse directions. The various averages for these dimensions are given in Figure 1, under their respective headings. The antero-posterior measurements were taken from the most dorsal point of the tuberculum sellæ in the sagittal plane to the anterior edge of the dorsum sellæ in the same plane. This represents the true antero-posterior dimension of the outlet of the pituitary fossa. The vertical or depth measurement was taken along a line dropped from the antero-posterior line to the deepest point on the floor of the sella. The greatest transverse measurement, or width, represents the distance between the lateral boundaries of the fossa. These figures do not vary greatly from those obtained by other observers, and various discrepancies are probably due to the different methods of measurement elected.

Fitzgerald, in a study of one hundred skulls, endeavored to show a relationship between the size of the pituitary fossa and the skull. He adopted two measurements, one taken from the tip of the ethmoid spine of the sphenoid to the anterior limit of the optic groove (anterior measurement of the basis cranii), the other from the opisthion to the middle of the dorsum sellæ (posterior measurement of the basis cranii). He also measured the length, breadth, anterior depth and posterior depth of the fossa. From these he concluded that the length of the fossa reaches its maximum when the posterior measurement of the basis cranii is greatest, and varies directly with it. The length of the fossa was more influenced by variations in the posterior measurement than in the anterior measurement. Fitzgerald also concluded that there was an inverse ratio between the length of the fossa and the anterior measurement of the base. He found the average length

[1] Work done in the Section on Pathologic Anatomy, under the supervision of Dr. H. E. Robertson.

measurement of the fossa to be 1.16 cm. and the average anterior and posterior depth measurements to be 0.70 and 0.78 cm., respectively. His study of the various shapes of the fossa showed the oblong and cuboidal types to prevail.

Cope, in a study of the pituitary fossa in fifty skulls, concluded that normally there is a great variation in its size, so that there is no particular age at which any special increase occurs. He could find no definite relation between the size and shape of the skull and the pituitary fossa. He obtained the averages of 10.94, 11.02, and 5.82 mm., respectively, for the antero-posterior, transverse, and depth measurements. The average depth measurement found by him is very low and misleading.

Gibson studied the relation of the sphenoidal sinus to the sella, and in his sections of the skull measured the length and depth of the pituitary fossa. He found the average antero-posterior measurement to be 1.2 cm. and the average depth to be 0.6 cm.

Jaugeas, from the observation of a large number of roentgenograms, placed the antero-posterior measurement at from 10 to 15 mm. and the depth at from 8 to 10 mm. He also quotes, without references, the measurements obtained from roentgenograms by Poirier, Destot, Koehler, Oppenheim, and Cushing. An average of the measurements reported by all of these observers gives an antero-posterior distance of 1.15 cm. and a depth of 1.02 cm.

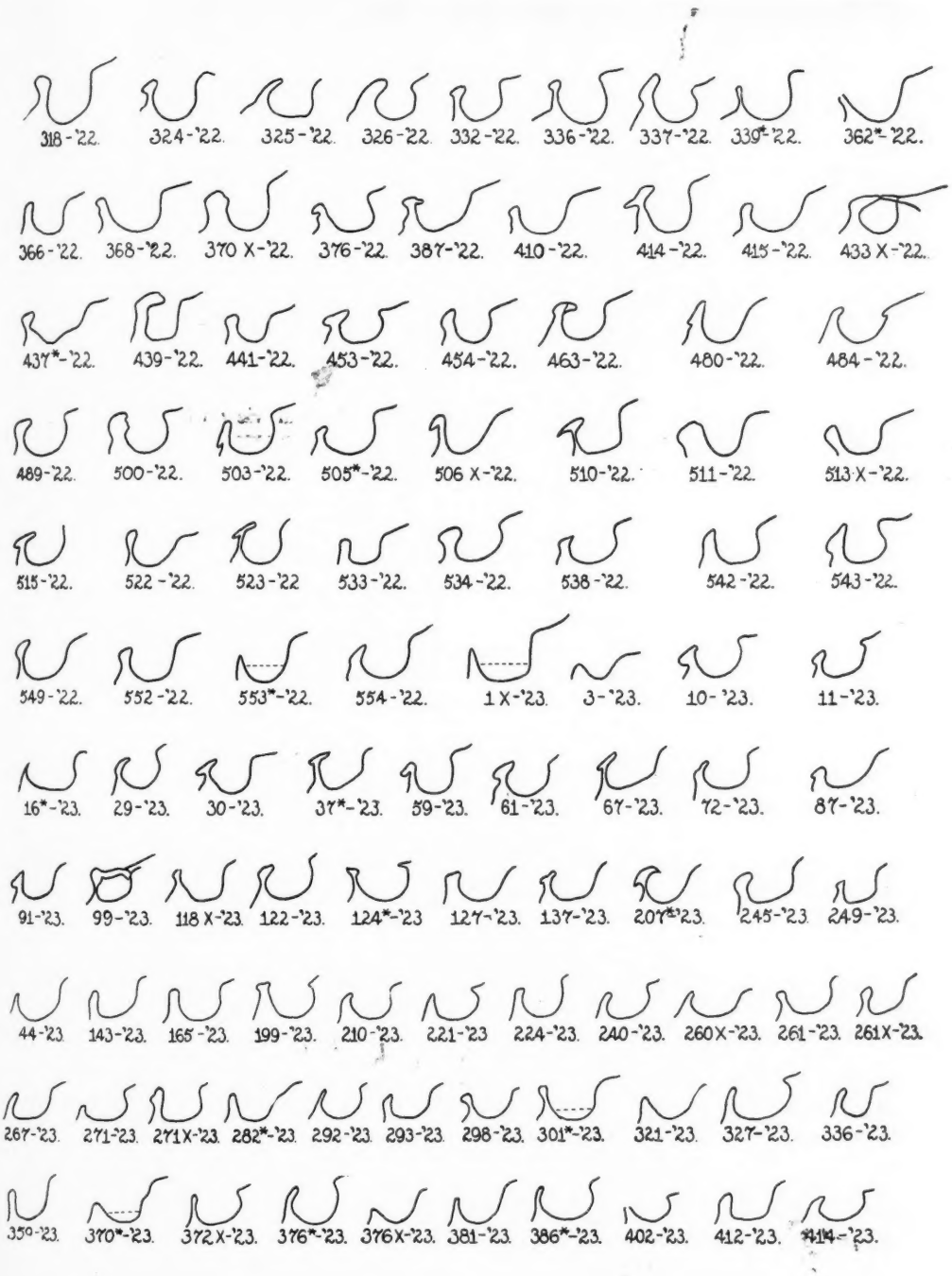
Variations in Contour

In order to obtain a true outline of the lateral contour of the sella, wax impressions were made in all cases possible; these were sectioned in the sagittal plane and their outlines traced, as shown in Figure 1. The outlines, starred, represent specimens showing changes in contour, due to increased pressure as a result of intracranial lesions. Many variations in contour are evident.

Jewett, from a study of roentgenograms of the sella in one hundred cases, endeavored to classify the variations in contour into eight types. This classification is too complex for practical purposes, for the dividing line between so many types is very uncertain and renders an accurate classification difficult.

Gordon and Bell, in a roentgenographic study of the sella in normal children, classified the various shapes into three types: the circular, oval, and flat. This is a more practical and applicable classification than the one proposed by Jewett. The circular type was found in seventy of the cases studied by them, the oval in twenty-five, and the flat in ten. These authors also conclude that there is no relation between the size of the head and the size of the sella, and that the shape of the sella has no significance except in the flat group, which is always found in small heads. Although I have not verified this latter statement anatomically, it is contrary to the deduction by Fitzgerald that the length of the fossa is proportionate to the posterior measurement of the basis cranii.

Applying the classification of Gordon and Bell to the series reported here, the oval type was found in 66 per cent, the round in 21 per cent, and the flat in 13 per cent of the specimens measured. The greatest antero-posterior dimension of the pituitary fossa was measured from the outlines in the sagittal plane along a line from the anterior wall to the farthest point on the posterior wall in the horizontal plane. The average distance of this dimension was 1.14 cm., the maximal distance 1.5 cm., and the minimal 0.8 cm. The average distance for this measurement will be somewhat more than that of the antero-posterior distance of the outlet of the fossa, due to the anterior curving of the dorsum sellæ in the majority of specimens.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91-'23. 99-'23. 118 X-'23. 122-'23. 124*-'23 127-'23. 137-'23. 207*-'23. 245-'23. 249-'23.
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267-'23. 271-'23. 271 X-'23. 282*-'23. 292-'23. 293-'23. 298-'23. 301*-'23. 321-'23. 327-'23. 336-'23.
350-'23. 370*-'23. 372 X-'23. 376*-'23. 376 X-'23. 381-'23. 386*-'23. 402-'23. 412-'23. 414-'23.

Fig. 2 *a*. Bilateral bridging of the sella, more marked on the left side. The pituitary fossa is not encroached on by the presence of the bridge.

Fig. 2 *b*. Lateral view of bridged sella, which gives the erroneous impression that the fossa is diminished in size by the bridge.

The distance between the various clinoid processes given in Table 1, was measured as follows: "A" represents the distance between the right and left anterior clinoid processes, "P," the distance between the right and left posterior processes, "L," the distance between the left anterior and the left posterior processes, and "R," the distance between the right anterior and the right posterior processes. Union between the anterior and posterior clinoid processes, producing the so-called "bridged sella," was found in six cases, 5.5 per cent. It varied from a heavy bony union to mere apposition of the clinoid extremities. In

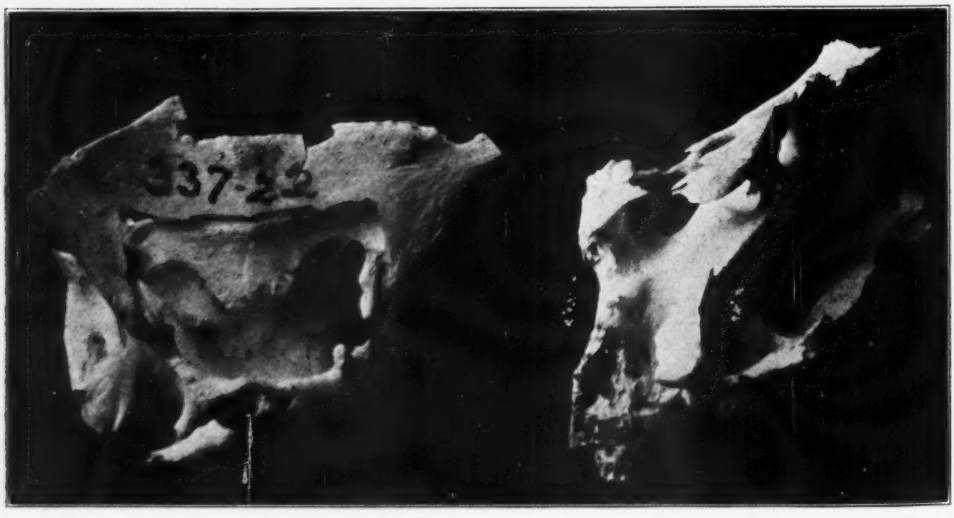


Fig. 3 *a*. Unilateral bridging of the sella. The capacity of the sella is not diminished by the bridge.

Fig. 3 *b*. Lateral view.

one of these the bridging was present on both sides (Fig. 2). Jewett, in a roentgenographic study of the sella in one hundred cases, reported bridging in 10 per cent. This percentage, I believe, is too high and could not be proved anatomically. The roentgenographic diagnosis of a bridged sella is so dependent on a correct lateral focusing technique, that the error of apparent bridging, pro-

Fig. 4. Erosion and pointing of the clinoid processes due to increased intracranial pressure from a glioma of the pons.

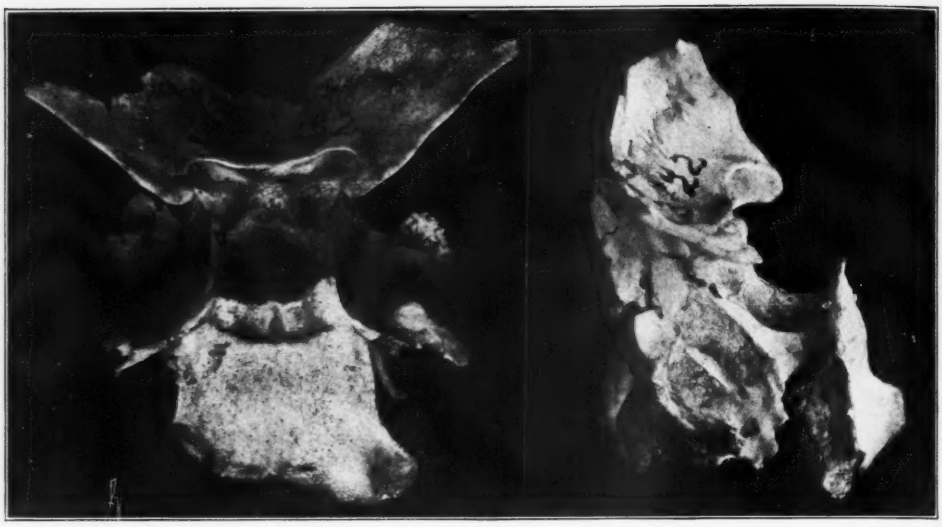
duced by the overlapping shadows of the anterior and posterior clinoid processes may result, if a careful technique is not adhered to. This technical error is, I am sure, responsible for many of the cases of so-called bridged sella.

The presence of the middle clinoid process is variable. When present and united with the anterior clinoid process, a foramen is formed through which the internal carotid artery passes. When a bridged sella occurs, the middle clinoid process may or may not take part in the union. Contrary to the belief of Johnston, whose work was based on roentgenograms only, in no case where bridging occurred was the capacity of the pituitary fossa encroached on by the bony bridge (Figs. 2 and 3). It is evident from this that bridging is not a factor in the cause of diabetes insipidus or epilepsy by provoking pressure on the

Fig. 5. Marked destruction of the clinoid processes and sella by pressure from a gumma of the brain. Only dura and sinus mucous membrane separated the pituitary and middle cranial fossa from the sphenoidal sinus.

pituitary gland, infundibulum, or blood vessels going to or from the gland. The occasional finding of a bridged sella in patients complaining of diabetes insipidus or epilepsy must be considered as coincidental, as this anatomic variation

Fig. 6. Marked erosion of the floor and dorsum sellæ, caused by pressure from a glioma of the left temporo-parietal area.



Figs. 7 *a* and 7 *b*. Marked erosion and "cupping" of the floor of the sella due to increased intracranial pressure resulting from a papillary tumor of the fourth ventricle. Sphenoidal sinus confined to presphenoid bone.

was found in 5.5 per cent of cases, none of which manifested either disease.

Variations in the size and shape of the clinoid processes were numerous. The dorsum sellæ mounting the posterior clinoid processes varied from a heavy bony process to a thin fragile structure. In a few instances in which a large sphenoidal sinus was present, the air space was found to extend up through the dorsum sellæ into the extremities of the posterior clinoids.

Fig. 8. Marked "cupping" of the floor of the sella and destruction of the posterior clinoids, caused by internal hydrocephalus. Rudimentary sphenoidal sinus confined to the presphenoid bone.

As a result of increased intracranial pressure, erosion of the clinoid processes occurs, with pointing of their extremities (Fig. 4), and with continued pressure the entire process may become completely destroyed. As a rule, when a unilateral lesion provoking pressure exists, the erosion is more marked on the side of the lesion. The posterior clinoid processes are more easily eroded than the anterior, and in cases of markedly increased intracranial pressure may exist as only mere remnants of the original structure (Figs. 5, 6, 7, and 8).

Whenever pressure is brought to bear on the pituitary fossa there occurs a change in its contour, the character of which is dependent on the source of the pressure. When it is the result of a growing pituitary tumor, the resulting pressure produces a uniformly circular enlargement of the fossa at the expense of the anterior wall, floor and dorsum sellæ. Figure 9 illustrates a very early

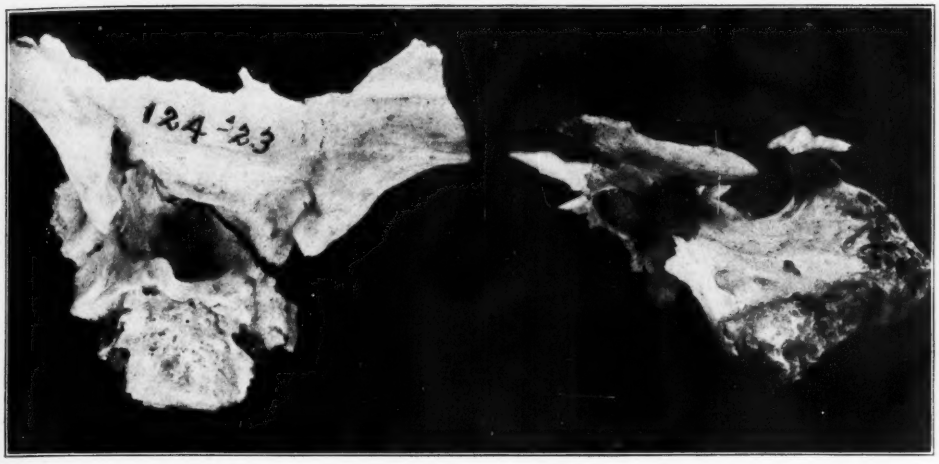


Fig. 9 *a*. Early change in contour due to an adenoma of the pituitary. Basal fracture of the skull extending through the floor of the fossa.

Fig. 9 *b*. Lateral view, showing hollowing and early circular erosion of the dorsum sellæ.

change in contour as a result of an adenoma of the pituitary. The specimen also shows a fracture through the floor of the sella, the result of trauma before death. Pressure which is exerted by a general increase of intracranial pressure, or pressure directly above the sella, produces a flattening of the sella due to erosion of the dorsum sellæ, floor and anterior boundary of the fossa. This flattened type of destruction, due to pressure resulting from extrasellar lesions, should be differentiated from the characteristic, uni-

Fig. 10. Erosion of the floor of the sella produced by a brain abscess following a bullet wound. Death occurred 37 days after the injury and 9 days after clinical evidence of abscess of the brain and increased intracranial pressure.

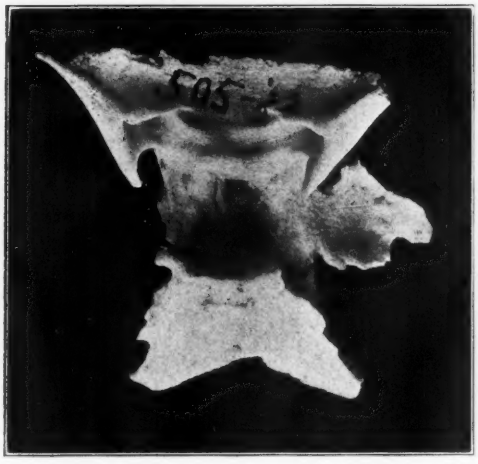


Fig. 11. Destruction of the floor with "cupping" and erosion of the clinoid processes, produced by cerebello-pontine angle tumor.

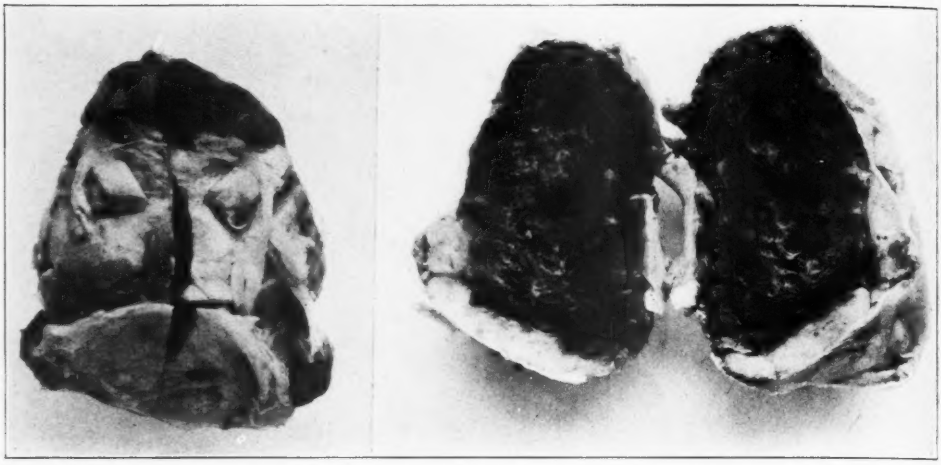


Fig. 12 *a* and *b*. Entire replacement of the body of the sphenoid bone and sella by multiple myeloma.

formly circular enlargement produced by tumors originating within the sella. Erdheim observed the latter deformity in a case of acromegaly, and was the first to utilize the variation in the deformities in distinguishing between intrasellar and extrasellar lesions.

The relationship of the sphenoidal sinus to the floor of the pituitary fossa, which has been carefully studied by Gibson, determines, to a great degree, the amount of destruction by pressure on the floor of the fossa. In young subjects in whom the sinus is not fully formed, but confined to the presphenoid bone, the floor is not undermined by an air space, but formed by the basisphenoid bone. In these cases, as illustrated in Figures 7 and 8, the pressure results in a marked cupping of the floor, as a result of erosion of the basisphenoid bone. The sagittal sections of specimens 553-22, 1-23 and 301-23, in Figure 1, show the degree of cupping produced. The dotted line represents the lateral boundary of the fossa, and the solid line, the deepest portion of the fossa in the sagittal plane. If a large subsellar sphenoidal sinus exists, the pressure produces complete erosion of the thin bone forming the floor, and we find only dura and sinus mucous membrane separating the fossa from the sphenoidal air space. Various degrees of destruction, depending on the degree and duration of the pressure, were observed (Figs. 5, 6, 7, 8, 9, 10 and 11).

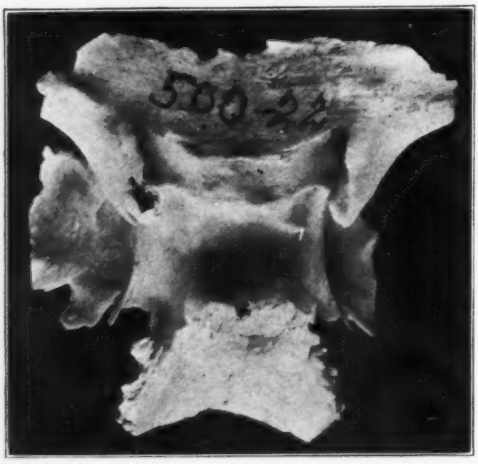


Fig. 13. Area of metastases in the left anterior clinoid process, from a melanotic sarcoma.

Destruction of the floor by pressure occurs early. A patient who had been shot through the head died thirty-seven days after the injury, and nine

days after the appearance of clinical evidence of abscess of the brain and increased intracranial pressure. The pressure exerted by the abscess in this short time was sufficient to produce the erosion of the floor, as illustrated in Figure 10.

Tumors within, or disease of, the sphenoid bone may provoke changes in its contour and structure. Figure 12, taken from a case of multiple myeloma, shows complete replacement of the bony structure of the sphenoid by tumor tissue. Figure 13 shows an area of metastases within the left anterior clinoid process from a melanotic sarcoma.

The many variations in the size and contour of the sella turcica found normally and in pathologic conditions make the decision as to decrease or increase in size, or a change in contour of the fossa, very difficult. By comparison of the anatomic specimens with the roentgenograms of the same specimens taken before the necropsy, it is hoped that the significance of many of the changes observed in roentgenograms may be demonstrated.

TABLE I

Sella Turcica and Clinoid Processes

Measurements					
	Antero-posterior		Depth		Greatest-Transverse
Maximum, cm.	1.6		1.5		1.8
Minimum, cm.	0.7		0.4		0.8
Average, cm.	1.07		0.8		1.21
Clinoid processes					
	Anterior	Posterior	Left	Right	Left and Right
Maximum, cm.	3.2	2.2	1.5	1.5	
Minimum, cm.	1.2	1.0	0.2	0.3	
Average, cm.	2.23	1.65	0.66	0.66	
Bridging, cases			5	2	1
Total number of sellæ measured, 100					
	Number	Maximum age	Minimum age	Average age	
Males	68	75	5*	45.07	
Females	32	87	18 months	44.7	
Average general age 43.9 years					

*One stillbirth

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FORECARE AND AFTERCARE IN ROENTGEN RAY THERAPY

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IN surgery it is self-evident that a certain definite forecare and aftercare must be employed to obtain the best results. In X-ray therapy this requirement is not as thoroughly realized as its importance would seem to warrant. This is due to the fact that X-ray therapy has developed within a few years from modest beginnings, and is as yet but slightly familiar to many physicians.

Generally speaking, special clinics for X-ray treatment do not exist. As a result of the rather simple therapeutic procedures from which deep therapy has developed, ambulatory treatment is still widely prevalent, a condition in which the pecuniary circumstances of our times play a role.

Thus it occurs that the forecare and aftercare of patients treated by deep therapy is only rarely placed in the hands of the roentgen therapist, but is more often under the control of an associate or house physician, whose knowledge of roentgen therapy is often derived only from occasional references in the literature.

Efficient deep therapy cannot be restricted to the application of a quantity of rays, but must take account of all the circumstances which concern the avoidance of injury, on one hand, and strengthening the body in its fight with cancer, on the other. Even though the roentgen therapist is obliged to leave the aftercare of his patient to other physicians, he does not lose the possibility of influencing both the preliminary and after care. It is, therefore, his duty to instruct the associate physician and prescribe rules for the patient.

A.—Forecare

Before radiation is carried out, certain demands are made of the attending physician and of the patient himself which must be executed before the treatment is instituted, and which we consider just as important as the preparation for an operation. The preparations required depend on the nature of the disease, and the plan of treatment.

The purpose of this forecare is to influence favorably the conditions for radiation. It begins with an explanation of matters to doctor and patient, for there are many invalids who think that roentgen therapy is quite simple, consisting of a brief application of the rays, followed by a pleasant siesta on a chaise longue, or a rest in bed reading. Such patients are naturally astounded when they are told that several days' hospitalization, or other preliminaries, are necessary for a long-continued radiation.

Usually a long interview with the patient is required, and takes much of the busy roentgenologist's time. There are also many physicians who are not well oriented as to the long duration of the treatment and other radical measures necessary for the radiation of cancer, and it is sometimes embarrassing both for the roentgenologist and the house doctor when the former is obliged to tell the patient that the house doctor's information was wrong.

Just as there are patients who conceive radiation to be a simple, short procedure, there are others who are very apprehensive of it and procrastinate rather than submit to treatment opportunely. In the foreground is the fear of burns, which is not entirely unjustified when we consider the number

of burns that have occurred since X-ray treatment began. There are also patients who have been told gruesome tales regarding X-ray treatment and who then proceed to frighten other patients. It must not be forgotten that occasionally faulty installation of apparatus is responsible for such stories, and it is the therapist's duty to arrange open spark gaps and parallel spark gaps so that the imagination of the patient will not be unduly stimulated by noises and flashes of light.

For the instruction of patient and physician we carry out the following system:

When a patient is to be treated we state to his physician the method and probable duration of such a treatment, as well as the length of stay at the clinic, and ask him to instruct the patient accordingly. If the patient is transferred to the X-ray treatment clinic, further management by the attending physician becomes unnecessary. However, if the case is sent by the house physician only for irradiation and leaves our clinic immediately after the treatment, the attending physician must be given instructions.

These comprise, on the one hand, verification of the diagnosis, and, on the other hand, actual preparation for irradiation. As to checking up the diagnosis three examples may be given:

1. *Climacteric Bleeding.* When in these cases there is the slightest possibility of cancer, excision of a specimen must be made before treatment is given. This can be done by any qualified physician, either at his office or the patient's residence. In all cases, however, we request that the specimen, which can easily be preserved in 10 per cent formalin, be sent to our laboratory. If the doctor does not take a specimen we ask that the patient be instructed that she is coming to the clinic not only for irradiation but also for preliminary curettage.

2. *Uterine Cancer.* If the diagnosis of cancer of the cervix and body has been made and the disease is so far advanced that the diagnosis is very clear, we do not ask for verification by excision of a specimen, because it has been shown that in carcinoma any kind of excision may have an unfavorable influence on its final healing.

If the case is not absolutely certain clinically, there is naturally no recourse except to excise a specimen, because we adhere to the principle that a cancer treatment should not be imposed upon the patient when the diagnosis is in doubt. Thus, in one of the above described ways the doctor verifies the diagnosis.

For the forecare of irradiation the following principles apply:

We shall give a description of the treatment of uterine cancer. In this irradiation the surrounding tissues are considerably affected by it, especially the mucosa of the bladder and rectum. Loops of small intestine may also occasionally lie in the irradiated field persistently, especially if they are fixed near the uterus by adhesions. To determine this it is not sufficient to inquire regarding past diseases, but in doubtful cases we regularly make a fluoroscopic barium examination with palpation.

In some cases, also, a portion of the transverse colon may be drawn down and fixed, as is shown by the roentgen pictures. If these coils of intestine can be pushed aside, then no attention need be paid to them in the process of irradiation because during the treatment they will of themselves change their position. But if they are shown to be fixed, arrangements must be made with special attention to this point. Usually irritation of the colon is more pronounced if hard fecal masses, or substances such as barium, are present, giving rise to secondary rays. Hence, we take care that patients who have been rayed for diagnosis are cleaned

out thoroughly with cathartics and enemata. In patients who have not been given barium one or two enemata are sufficient, given the day before and the day of treatment.

It is well to consider the condition of the bladder before treating uterine cancer. If careful urinalyses show evidence of bladder inflammation, then, as a rule, the irradiation is not pushed so far until the state of the bladder is improved, and after irradiation special care is necessary. The bladder is first taken care of for a few days and it is attempted to improve its condition by appropriate medicines, plenty of water by mouth, and lavage. If this is unsuccessful after a few days, then the irradiation is carried out regardless of the bladder irritation in order to avoid further proliferation of the cancer.

Just as a complete physical examination is made before an operation, so must one be made before roentgen treatment. This begins with an exhaustive anamnesis. Further, it must include the condition of the skin in the rayed area, the heart, and the blood picture. Serious cardiac changes are rarely a contra-indication even to very lengthy irradiation for cancer, but if there is sufficient time before irradiation, treatment with digitalis is indicated the same as before operation.

In raying mammary cancer, a thorough examination of the lungs is of prime importance.

Examination of the blood is important, because when its condition is bad, with a leucocyte count under 2,500, in conjunction with a lymphopenia and a hæmoglobin index below 40 or 35 per cent, a cancer treatment should under no circumstances be given. The blood is also of importance in indicating the reaction to irradiation. If one has a few weeks' time before treatment, which is permissible only in the rarest cases, it is expedient to give general treatment with a course of arsenic.

The importance of a careful anamnesis is obvious, for under no circumstances should the above mentioned irradiation be applied with indifference. Of outstanding importance are iodine applications and mercury treatments, making the skin intolerant to the X-ray. Besides, there are diseases with an excessive sensitiveness of the skin, such as Basedow's, in which it is increased about 25 per cent, certain types of diabetes, and some forms of kidney disease.

For the irradiation itself we have a rule that the patient shall come with an empty stomach or at least take a very light breakfast. When intestinal disturbances are present we prefer to wait a few days rather than irradiate the patient in such condition. We pay much less attention to the immediate condition of the patient than to the fact that in cases of bowel disturbance the reactions following irradiation are worse because the toxins cannot so readily be eliminated.

B.—Aftercare

After-treatment of the patient following irradiation for cancer must be carried out even more scrupulously than the preparation for treatment. In every case it must meet all the symptoms following the treatment. Theoretically four great factors resulting from irradiation are to be met:

1. Care of injuries ensuing upon roentgen therapy, which occur in greater or lesser degree even in healthy tissues, and which may be classified as general and local.
2. Elimination of degeneration products resulting from disintegration of tumor cells, and neutralization of toxic metabolic products in normal cells.
3. Support of the body to secure an enduring resistance against cancerous disease.
4. Replacement by healthy tissue at the site of the cancer.

While in suitable cases we are able to bring about systemic improvement by various means (metallic salts, colloids, protein bodies, products of internal secretory glands) we lack that true stimulant which specifically aids the body to regenerate. Further, we cannot aid directly in the elimination of the products of destruction. At most, by our therapy we obtain a modification of the injuries.

Irradiation injuries may be classified in two groups, local and general. Among the latter, blood changes play an important role.

The gravity of local tissue injury depends on the amount of radiation used and the condition of the tissue. In this matter of local tissue injury, special attention must be paid to the possibility of combination injury. By this is understood an injury which appears only when the irradiated tissue is acted upon by some additional agent.

To-day we know that as a specific result of the X-rays a locus minoris resistentiæ is produced in the rayed tissues. This occurs even with 50 or 60 per cent of the erythema dose. In such tissue neither macro- nor microscopic changes are to be found. If such tissue is acted upon by a second irritant, thermal, chemical, or traumatic, changes appear out of proportion to the amount of the second agent.

Naturally, the degree of lowered resistance is increased as the irradiation dose approaches the limit of tolerance. For the skin it is known that this limit is 100 to 105 per cent of the erythema dose, so it is apparent that ulceration or even deep necrosis may result if another irritant is superadded. For this reason we forbid the use of hot water bottles, electric pads, radiated heat, and sunlight after X-ray treatment, and we also forbid applications of an ice bag. Moderate heat under some circumstances is tolerated, but even baths at a temperature of 38 or 39 degrees C. may be irritative.

We also regard it as necessary to forbid the use of all chemical reagents as salves or rubs (iodine, vasogen). It should be noted also that washing with benzine, benzol, or terpentinol may induce severe reactions in irradiated skin.

In practically every irradiation for cancer the skin at each portal of entry must be given an erythema dose in order to achieve a deep cancer dose. Hence, especially in the aftercare of cancer treatment, the danger of a combination injury must be borne in mind, and minimal traumatic influences may change the slightest erythema into a severe form, even ulceration. Therefore the first essential is to instruct the patient regarding these possibilities. All forms of pressure, such as that from collar bands, coat collar, and garters on the irradiated area must be avoided. Likewise chafing from clothing or rubbing corset steels must be interdicted. It is important to forbid pulling or scratching the irradiated area. Baths must not be too hot. A pure mild soap is essential. We have often seen irritation from strong soaps.

For care of the skin we have found of value pure unguentum leniens, prepared as follows:

Cera alba	2.1
Cetaceum	2.4
Ol. oliv.	18.
Aq. dest.	7.5

We recommend the use of this salve for three or four months after treatment. To avoid irritation from the fatty acids the salve is washed off from time to time with a mild soap.

The induction of a locus minoris resistentiæ holds true for every type of tissue. For mucous membrane the locus minoris resistentiæ need be considered only after highly intense irradiation, and only with still greater degrees of intensity does the musculature or connective tissue become affected. We must consider the possibility of injury

to the bladder and rectum and take proper precautions.

We have already pointed out under "Forecare," that irritations of the bladder and altered chemical composition of the urine may possibly give rise to combination injuries. Concretions in the bladder cause unpleasant results. We routinely urge the patient who has had a treatment in the vicinity of the bladder to drink freely, and certain well-known waters are not always desirable for this purpose.

Properly conducted irradiation rather seldom produces irritation of the bladder. If it occurs often it is the result of an improper technique (as, for example, in the treatment of uterine cancer) or of failure to carry out our warning that during irradiation, the bladder is to be emptied at each change of portal, or at least every hour.

Rectal injuries are of much greater practical importance, for they cannot be avoided in raying a uterine cancer. Areas of the bladder bear a dose which would exceed the limit of tolerance for the rectum. There is always the possibility of a combination injury to the rectum, especially when the fecal matter passing through the irritated areas is very hard. We therefore watch the condition of the bowels very closely after irradiation for uterine or intestinal cancer. Of prime importance in this regime are enemata and oil instillations (5 to 10 ccm.). Some patients prefer suppositories filled with liquid paraffin. We instruct the physician and patient that these attentions to the bowel must be continued for about two months after irradiation. For the maintenance of a soft stool we use the following powder:

Mag. perhyd (Merck).....30.0
Na bic 20.0
P. r. rhei.....15.0
Bismuth subnitr 7.0
Bismuth subgallate 5.0
Carbo anim (Merck)..... 3.0

Sig: Three times daily after meals.

[The number of powders into which this is to be divided is not stated.—Trans.]

Among the local irritations which offer the possibility of combination injury are those of the oral and pharyngeal mucosa. For a few days after irradiation of cancer of the larynx there is always the possibility of œdema of the glottis developing. After irradiating a cancer of the tongue there is a chance of combination injury by food. Neither very hot nor very cold food should be taken.

To the so-called local injuries may be added the induration of rayed tissue which almost always occurs if a certain area is irradiated two or three times, even at long intervals, with a dose which approaches the toleration point (90 to 100 per cent of the erythema dose). Any rough handling of this œdematous induration must be avoided. We have seen phlegmons and even tissue necrosis in cases in which the indurated area had been incised through ignorance.

Induration of the lung, which frequently follows systematic irradiation of mammary cancer, must also be considered. In general it is harmless, and under no circumstances requires active after-treatment. Its recognition, however, is of importance, and it is especially apparent if inflammatory processes occur (bronchitis, pneumonia) and run a more severe course than in sound lungs. The sole medicament which has thus far proved of value is camphor. All expectorants have been found to act unfavorably. It must be added that the lung induration often presents a very dangerous locus minoris resistentiæ in an attack of influenza.

Generalized injury also presents itself in all degrees from *nil* to the most severe intoxication.

General damage which follows every irradiation results from the biochemical action of the roentgen rays, and, in the case of some tumors, from the liberation of degeneration products from the cells acted upon by the rays.

That the roentgen rays are capable of affecting the cell metabolism harmfully need not be discussed here.

Mention must be made also of the electrical phenomena which affect the various cells during irradiation, and wield an influence in the production of intoxication. During treatment the patient is charged with three or four thousand volts. Alternating currents arise which disturb the electrical interrelationships between the cells. By these continued electrical charges and discharges, the chemism of the cells is affected.

The basis of so-called roentgen sickness is in these intoxications. We must not forget, however, that roentgen sickness in many patients is influenced by psychic factors, for we have often seen it occur when a patient is directed to go into the section of the clinic where heavy doses are given. It is well known that the severity of the sickness depends on the site of irradiation, and that irradiation of the abdominal organs is usually followed by marked sickness. Moreover, pollution of the air with nitrous acid and, above all, by ozone and its compounds, tends to increase the trouble. Another important element in the production of roentgen sickness is a rapid cell destruction which begins even during the process of irradiation. Hence, it will be noted that severe roentgen sickness is especially common with tumors, such as lymphosarcomata, in which regression is observed during treatment. In such cases we have seen intoxications which remind one of a protein reaction and which may go on even to diarrhœa and coma. Roentgen sickness is doubtless unpleasant for the patient, but it is also disagreeable for the doctor because if the patient vomits severely during treatment the irradiation must be stopped, and frequently the entire arrangement of the patient and the protective coverings must be made over again. If these vomiting spells are frequent one is uncertain as to the results of the treatment. Patients who have gone through a siege of roentgen sickness dread further treatment. Severe sickness has sometimes been a reason for not finishing the treatment, with consequent poor results. Thus it would be fortunate if some means could be found of counteracting it. In the literature we find a long list of remedies, all of which have been effective in one case or another. However, no reliable method has been found.

Naturally, various means are employed. A thoroughly executed scopolamin-pantopon twilight sleep is to be recommended, but cannot be used in all cases. Electrostatic protection of the patient by grounding has an excellent effect, but is not applicable to near areas (tube fields). Anæsthesin—25 drops in a small glass of red wine—will now and then be found satisfactory. On many patients, inhalations of menthol have a quieting effect. It is of greater importance that the bowels be thoroughly cleansed out for some days preceding the irradiation, so that they will be empty during treatment. This is also the basis for rapid elimination of toxic products after the treatment. In some patients the nausea, headache, and antipathy for food are well prevented by normal saline solution given by the drop method. If these measures are observed the troubles directly following irradiation will seldom persist longer than two or three weeks. These effects are often very severe if the patient undertakes a railway journey after intensive treatment.

Blood changes hold a special place among the general effects. They stand in direct relation to the amount of radiation received by the body. In an ordinary irradiation we are interested in the amount of irradiation given locally. For blood injury, on the other hand, the amount of radiation absorbed by the entire body must be taken into account.

In order, therefore, to establish a comparison between roentgen ray intensity and the amount of blood injury we have taken a volume-dose as a unit. This unit, designated "A," corresponds to the amount of radiation received at 180 k. v. with a 0.5 mm. zinc filter, at 23 cm. focal distance, in a pyramid of tissue with a base of 6 by 8 cm. and a height of 15 cm. With this the skin will receive an erythema dose. The types of the various media in the body naturally play a certain role but our observations have shown that these differences offset each other when the entire body is taken into consideration. With 2½ or 3-A the first blood changes appear, which, however, quickly vanish. Taking this volume-dose as a base, the results are about as follows:

The blood changes noted are, to a certain degree, typical. Thus with an amount of irradiation as is used in uterine cancer, there is a lowering of the hæmoglobin, and marked decrease in the number of leucocytes, especially lymphocytes. Coagulation time is affected. This is largely dependent on the intensity in a unit of time. With high intensity, coagulation time is shortened; with less intensity, and if the dose is divided by about ten-hour intervals, coagulation time is lengthened.

So marked are the immediate blood changes, that, in our experience, about six weeks are required to restore the original blood picture.

In some cases the original status is never regained, and such patients give unfavorable results otherwise. However, since 1914 we have not seen a single case among our large number in which a patient died as a result of acute blood destruction. Consequently, we believe that injury to the blood from the X-ray is comparatively benign since the body has great power of restitution. Yet in every blood case, the blood must be carefully watched; it gives the best indication as to the prognosis of the case. By blood transfusion, introduced in recent years by Warnekros, it is possible in many cases to improve the blood picture and thus better the general condition, perhaps by activation of protoplasm (Weichardt). Nevertheless, from our experience we are of the opinion that even blood transfusion is of no value if the regenerative power of the body has failed.

Our own observations and the statistics of other writers have shown that early operable cancers react best to roentgen treatment, that is to say, cancers associated with a good general condition. It is clear that irradiation only destroys a neoplasm, and it devolves upon the body to throw off the products of degeneration. Therefore, our chief aim in the aftercare must be to aid the body in its task by improving living conditions, by sparing-processes and good nourishment. Cachectic patients are not equal to the great strain and often show poor results even though there are no distant metastases.

This problem of raising general body resistance can be solved only by close co-operation between the house physician and the clinic. There will always be cases in which it is impossible to carry out special hygienic measures. When possible, however, the patient should be instructed that irradiation offers only a basis for recovery, and that general dietetic management is also necessary. To this end, living in the open air and the best of food should be ordered. Roborants may also be prescribed. For improvement of the blood we have found two ferro-arsenical preparations to be valuable, "eisenelarson" by mouth, and "arsacetin" subcutaneously or intramuscularly.

We give "eisenelarson" as follows: Three tablets a day for five days, four tablets for five days, five tablets for five days, and so on until twelve tablets are taken daily for five days, and, if the

patient bears them, up to fifteen tablets daily for five days; then the dose is gradually diminished, so that in a period of 95 days the patient is given a total of 690 tablets. In the second course of 125 days he gets 1,095 tablets. As each tablet contains half a milligram of arsenic and thirty milligrams of iron, the patient has received in the entire treatment 32.85 grams of iron and 0.5475 of arsenic.

Not all patients tolerate ferro-arsenicals by mouth. For this reason we prefer "arsacetin" injections (Lucius and Bruning, agents). A 5 per cent solution is injected subcutaneously or intramuscularly as follows: First week, daily, 1 ccm.; second week, daily, 2 ccm.; third week, daily, 3 ccm.; fourth week, every second day, 4 ccm.; fifth week, daily, 3 ccm.; sixth week, daily, 2 ccm.; seventh week, daily, 4 ccm. In using this preparation we have never had any ill effects if the above amounts were not exceeded. Often patients do not well tolerate "arsacetin." Then it is best to break off the treatment and try some other preparation. In one case we saw a slight ocular disturbance (conjunctival reaction) which quickly subsided, however. In a few cases in which "arsacetin" was not well borne, we had good results with "solarson."

Further may be considered casein injections, as recommended at the Freiburg Clinic, and injections of "elektroferrol" which, however, must be employed very carefully, as cachectic patients often react with a severe chill. A dose of 1 ccm. three times per week must not be exceeded.

General care of the patient must also be attended to. For example, in a case of uterine cancer with pronounced necrosis, lavage with potassium permanganate or hydrogen dioxid should be ordered. Cauterizations and debridements are to be avoided the same as excision of specimens, as they hinder regression of the cancer and its conversion to normal tissue, mostly connective tissue.

The chief aim in the management of cancer must be the avoidance of all irritation of the irradiated cancer tissue. For example, in the roentgen treatment of a rectal cancer, a colostomy is essential, as the constant passage of fecal masses by injections make a quiet regression of the cancer impossible. In œsophageal cancer the X-ray treatment must go hand in hand with surgery, gastroenterostomy being requisite. These instances illustrate the necessity of close preliminary co-operation between the X-ray specialist and the surgeon. Various operations must be considered which will facilitate irradiation and promote its desired results.

From the foregoing it follows that a satisfactory result in cancer treatment does not depend alone on proper and thorough irradiation. A well-conducted aftercare decides the result, and even in apparently simple cases it presents new problems which must be taken seriously, for their final solution requires much experience.

THE ROENTGEN RAY IN NONMALIGNANT GYNÆCOLOGIC CASES: A CLINICAL STUDY[1]

By MARY ELIZABETH HANKS, M.D., CHICAGO

THE oft-repeated precept that the roentgen ray should not be applied in the presence of complications, is a doctrinal fallacy. During six years of X-ray treatment of uterine myomata I have been impressed that much good is done outside the main pathology—hence this clinical report.

Prefacing this discussion, it is well to say that my technique is much the same as that of former years, namely:

Nine inch spark gap (125,000 volts);

Seven to twelve inch distance (18 to 30 c.m.);

Five milliamperes;

Five millimeters of aluminum with sole leather as filters;

Five to seventeen minutes, time.

The cross-fire method is employed, through as many ports of entry, three inches in diameter, as are required to cover the pathology under treatment.

The above-outlined technique is not according to the trend of the times, but in my reading I find the question of dose in benign gynæcologic cases is still a debatable one and that the divided dose with the lower voltage is stoutly upheld by my peers.

Is it necessary to employ the new short-wave length in benign pathologies in the female pelvis when the dose estimates made by Seitz and Wintz, Wetterer and others, place the dose of all the tissues we are discussing as below the skin dose? (1) This is true with the single exception of carcinoma, the treatment of which is not included in this paper. The skin being rated at 100, the ovary is only 35 or less, while the other glandular tissues, and also the myoma cell, are all below 100. Not only do we get with the fractional dose the reactions we seek, but we more often avoid symptoms of roentgen sickness arising from too rapid disintegration of the tissues. A patient in this discouraged state is easily persuaded that X-ray is dangerous. After years of observation I am more than ever convinced that a sudden transition into and through the menopause is a physiologic outrage, and, no odds how spectacular the results, we are far away from the method Nature has endorsed, that is, a gradual adjustment from the years of active sex life and ovulation, to the nonproductive period. Reference is here made to but one of several authorities.

Professor Holzknecht, for years the leading spirit in the development of the massive dose and its measurement, said, at the Berlin Roentgen Congress: "Among my cases of strongly rayed myomata five developed hyperthyroidism, four hypertension, two distinct acromegaly and many gave clinical indications of marked ovarian irritation. Whereas, similar cases that were rayed feebly showed surprisingly excellent recovery, characterized by the absence of any untoward secondary endocrine effects. It is my belief, therefore, that we do not have the right, simply for the purpose of maintaining a uniform and easily conducted roentgen therapy method, to destroy more in the cure of a single case than is physiologically warranted." . . . "In the treatment of malignant tumors it is wise to seek the single maximum dose; but for all other sicknesses we shall have to return to the medium and fractional dose." (2) With such eminent authority, my contention is upheld.

When the short-wave length is proved to be better for cases herein described,

[1]Read before the Radiological Society of North America, Detroit, Mich., December, 1922.

and the technique is so standardized that the physician working alone in his office-laboratory on his own patients can safely adopt the same, I shall not be slow in making the practical application. Meanwhile, let us who must follow the lead of those technically equipped, await with patience the results of serious research.

Another thing about which we should come to an understanding is the word "cure." In medical discussions it seems to have such a variety of meanings that it is confusing.

As roentgenologists, being under critical observation, we must be more accurate. A patient "cured" should mean that the pathology under treatment is no longer demonstrable; absence of symptoms; a return to normal health. In this report the word "cure" is used advisedly.

If we review the tissue changes induced by X-ray it becomes more apparent why it is so accurate and dependable in a variety of pathologies found in gynæcologic practice. Briefly stated:

1. Ovarian stimulation is inhibited. The ripe and ripening Graafian follicles are destroyed; the primordial follicles are later affected if the application of X-ray is prolonged. This produces a permanent amenorrhœa. The internal secretions seem not to be affected in the average case, if the small ovarian dose is employed (1), (2), (3).

This is evidenced by the mild menopausal symptoms and by the absence of obesity. This fact has been noted by several authorities. Eden and Provis of London observe that "there is no corpulence nor psychologic change." (4)

2. Glandular tissue at first is stimulated, but if the ray is continued the secretion gradually disappears. This applies especially in this report to the utricular and cervical glands. Hypertrophy of the mucosa is reduced.

3. The endothelial lining of the capillaries becomes œdematous with a resulting endarteritis obliterans. (5) This lessened blood supply, induced artificially by the X-ray, naturally occurs in the female pelvis during the menopause.

4. In myomatous growths the cells, especially the nuclei, are obliterated. Finally nothing is left of the cells but detritus which is carried away by the leucocytes. (6)

It is a mooted question whether the changes in the tumor cells, noted by Simon, are a direct effect of the X-ray or indirect through the ovaries. That the changes do occur is not disputed, which is more pertinent to this study.

Adhesions, it was early noted, are reduced by X-ray. Also, indurated inelastic tissues throughout the pelvis approach the normal and a free circulation of lymph and blood is promoted. Tumors of the uterus bound down by perimetric adhesions become freely movable in most instances. This was early demonstrated by such men as Fraenkel, who characterized it as "a welcome addition to our armamentarium." (7)

Small ovarian cysts originating in the Graafian follicles (follicular cysts) are favorably influenced by X-ray. These cysts are usually due to a fibrous condition which prevents their rupture. Under the favorable influence of X-ray (or high frequency) they gradually recede. This is repeatedly seen during the treatment of fibroids and though we expect it, we never prognosticate it. The large ovarian tumor of any sort is never remedied by X-ray and is at once surgical.

Nonmalignant diseases of the cervix, such as erosions and degeneration of cervical glands, are very favorably influenced by X-ray. In my experience, no case has failed to come into perfect health, and the accompanying leucorrhœa gradually disappears. Some of the erosions have been chronic and threatening (and these are always po-

tential carcinomata), but if they are thoroughly rayed before actual malignant change occurs, their response to treatment is prompt and satisfactory. To date not one has retrogressed.

Several cases of pruritus vulvæ have recovered while treating a fibroid. The most common cause of pruritus is leucorrhœa. During and after the menopause it is often a slight, watery, excoriating discharge that is almost imperceptible. It is of different character if from erosions, cystic degeneration of the cervix or from a hypertrophic endometrium. My technique is based on a consideration of the pelvis as well as of the pruritus. In the average case a series consists of one or two X-ray exposures over the suprapubic areas including the entire uterus. Then the pruritic area is given approximately the same dose. Every three weeks this inclusive treatment is repeated, until it has been given five or six times.

The results are uniform. The average case comes into prolonged relief or cure. The intervals between treatments should not be more than three weeks or the results are less accurate. Relapses may occur if the leucorrhœa returns or if the patient suffers severe nervous strain or depressing experiences.

Dysmenorrhœa, those uncontrolled cases so disastrous to normal living and health, make up one of our most satisfactory groups. These have usually tried all forms of medical treatment, and all the remedial surgical procedures. They are pathetic examples of many failures, and if they are not drug habitues it is fortunate. X-ray in fractional doses should be employed even in younger women. In these, moderate doses and long intervals between series will sufficiently delay the menopause so that the shock is negligible. After the menses disappear it is good to see the long period of semi-invalidism end and the woman resume her living-making occupation or her normal place in family life.

A troublesome menopause, prolonged, nerve-racking, with its long train of distressing symptoms, should be terminated by X-ray. At this time the generative organs so readily assume the characteristic atrophic state that three series usually suffice. Not only for the good of the individual but for the benefit of the entire family this woman should be brought into a more normal attitude toward her surroundings.

Hæmorrhage of the menopause is promptly controlled by X-ray which is almost specific in any of the more common etiological conditions, as fibrosis, hyperplasia of the mucosa, chronic endometritis or endocrine unbalance. If in doubt as to malignancy, a careful diagnostic regime should be followed.

Sterilization is sometimes justified. Physicians and other humanitarians recognize that certain types should not reproduce their kind. I have now under treatment a woman of thirty-five who is fighting for her life because of an extensive tuberculosis. She has three small children whom she must attend. On medical advice she has had two pregnancies terminated. She has now a severe hæmorrhage from an enlarged retroplaced uterus. Her urgent needs are two, the elimination of hæmorrhage and of fecundity. I fully concur with her physician in that solution to her problem. Not only is it warranted in a pathetic case of this nature, but it is my conviction that X-ray sterilization is proper in habitual criminals, degenerates, submentals and in those who pass on to their progeny syphilitic blemishes. These people would submit to X-ray when they would refuse surgical sterilization. Roentgenologists can be of distinct service in helping to eliminate undesirable elements from the overburdened human race. So urgent is this

work that it has become an emergency and it should be recognized and authorized.

In the treatment of myofibromata the contra-indications are of prime importance. Because of them I refuse not less than 25 per cent of the cases that come to me.

1. Pedunculated tumors are unsafe and should be operated upon.
2. Submucous tumors are unsatisfactory, provoke complications and are surgical.
3. A tumor associated with severe anæmia, much tenderness and with history of fever and chilliness may be necrotic and is at once surgical.
4. A chronic tumor that suddenly grows rapidly may be undergoing some form of degeneration and is better operated upon.
5. A tumor associated with ovarian tumors (not simple follicular cysts) belongs to the surgeon.
6. A suspicion of malignancy puts the case into the hands of the short-wave expert, the radiologist or the surgeon or all of them.
7. A case associated with acute gonorrhœal infection, with salpingitis or pyosalpinx, is not benefited by X-ray.
8. A large non-vascular tumor, made up mainly of connective tissue, that does not bleed, is unfavorable for excellent results with X-ray though these cases may yield good results as to health and comfort.
9. A woman who desires children, whose subserous tumors can be enucleated, is a good subject for myomectomy.

Errors in diagnosis are made by the best gynæcologists but if we remember that any tumor not materially reduced after two or three series of X-ray belongs to the surgeon, we shall consume little time in error.

In making a survey of one hundred twenty-five cases of uterine fibroids, you can appreciate that it has been impossible for me to follow personally each one. I have arrived at my conclusions by records showing the character and tendencies of the tumor, by a knowledge of the condition at the termination of treatment, by subsequent examinations when possible, and by reports from the physician referring the case. A large majority of the cases submitted to-day have had confirmatory diagnoses made by other physicians.

This series includes tumors which vary in size from the smallest admitting of diagnosis to one the size of a full term pregnancy. (This woman's physician tells me her tumor is greatly reduced; that she is married and is keeping boarders.) We should not permit size, therefore, to occupy too important a place in estimating prognosis. Large tumors, conforming to the favorable type, may be very successful. One tumor which came an inch above the umbilicus has entirely disappeared, but this is unusual and is not to be expected. A small indurated tumor, with no history of hæmorrhage, recedes slowly and may not disappear.

The best case for treatment is the intramural myoma that is hæmorrhagic, that is not complicated, that grows below the umbilicus, that occurs in a woman of forty years or more. These cases, if the treatments are skillfully applied and are continued long enough, will yield almost 100 per cent in good results. It is this group that furnishes a large percentage of our cures, and this group is about 72 per cent to 75 per cent of all cases.

Our chief aim, however, should not be to make amazing records. There are cases that will not yield perfect results as to the disappearance of the tumor and yet may properly belong to the roentgenotherapist. This class is made up of women who are not good surgical risks; or of those who can not turn aside from the exacting demands of home or business; or of those

who are positive that they will not submit to surgery. After a full understanding as to prognosis all these should be given a choice of procedure if the end-results of X-ray promise a relief of symptoms and a return to reasonable health.

If one would attain the greatest success, he must become expert in diagnosis; must select his cases with care; and must make careful records of each case. If these are constant factors I concur with Doctors Eden and Provis, who conclude their report of seventy-six cases by saying that the risks of failures with roentgen ray treatment in suitably selected cases are so small as to be negligible. (8) In this there seems to be a general agreement among our most experienced and careful roentgenologists.

My first thirty cases, reported to you three and one-half years ago, are, as far as I can possibly estimate, about 80 per cent without palpable tumors. These were chiefly from my private practice. After the first thirty a less promising group was offered, such as poor surgical risks, cases in which relief only was sought and prognosticated. These cases cannot be rejected and are entitled to the benefits of X-ray, but they reduce the percentage of cures that my earlier records show.

Of the 125 consecutive cases about 75 per cent show no demonstrable tumors. There is no doubt this rate can be maintained with reasonably careful selection and by giving individual care to each case.

The remainder runs approximately as follows: 10 per cent are free from symptoms, in excellent health, tumors gradually lessening, but probably will not disappear; 7 per cent were relieved, general health improved, tumor reduced in size, menopause established, but because of serious complications the case not promising as to complete reduction of tumor and as to health. Three of this group died several months after treatment was concluded,—one from chronic heart disease, one from intestinal cancer not associated with the tumor, and one from pneumonia.

There were a few unfinished cases who became discouraged or alarmed and sought relief by some other method.

To discuss my failures is more to the point than to enlarge upon my successes. The three that came to operation were all mistakes in diagnosis. Not easy cases to diagnose, I contend, but mistakes.

The first was a case of myxomyoma. This woman after four series of X-ray and an operation conceived and delivered at full term a normal child. This is a very unique case.

The second was a fibrocystic tumor of ovary, occupying the median position. After three series, the results being unsatisfactory, the case was operated upon.

The third was a cystadenoma of the ovary. I still believe that this case had a fibroid earlier. The diagnosis was confirmed by two other physicians. At one time I told the patient to return in three months, when the tumor would probably be gone. After four months she returned with a tumor larger than the original, but it was very different. When operated upon, it proved to be a cystadenoma of the ovary.

The fourth was the only one in my entire experience that was not relieved of hæmorrhage.[1] The large tumor, unsuited to X-ray, was complicated with severe hyperthyroidism. The woman was a very poor surgical risk. After much X-ray, and three applications of radium in the uterine cavity, the hæmorrhage is apparently controlled. Though the woman still has a much reduced tumor, she is in excellent health to-day; but as her future is more or less uncertain, I am including her among my failures.

After six years it gratifies me to say

[1]Since reading this report, one other case was unrelieved as to hæmorrhage, though the tumor disappeared. This is a suspicious circumstance. A thorough diagnostic regime has been urged.

that to my knowledge not one of my cases has developed malignancy, either sarcoma or carcinoma. This gives me, however, no false security. On previous occasions before this body I have expressed the belief that X-ray remedies the pre-cancerous state and may even arrest the incipient cancer that has escaped detection. This has now become a conviction, and is in accord with others of wider experience and with better facilities for accurate observation.

To scare a woman into an operation by holding up to her the danger of malignant degeneration is unwarranted and unfair, especially if the following quotation from Dr. Lane is correct: "In surgery one must figure on about 14 per cent operative complications consisting of wound infections, hæmorrhages, peritonitis, thrombosis, embolism, injuries to other abdominal or pelvic organs, lung and heart diseases, nephritis, nervous mental disturbances or other accidental complications." (9)

Dr. John G. Clark said, apropos of the danger of sarcomatous degeneration in myomata: "I am glad, indeed, that Dr. Lawrence has brought into the discussion the perennial question of malignant degeneration in myomata. If there was ever a fallacy that should be annihilated, this is one. The frequency of sarcomatous transformations in myomata is so small as to be negligible. It is quite possible," he continues, "to take out of any fibroid tumor isolated areas which could be mistaken for spindle-cell sarcoma . . . I am sure, therefore, that the discrepancy in diagnosis lies in this difference of opinion." (10)

As to associated carcinomata and adenocarcinomata, there is always a larger percentage. Cullen, Johns Hopkins, finds 1 per cent in the cervix and 2 per cent in the body of the uterus. (11)

The assumption that a cancer operated upon is gone forever or that operating for myoma entirely disposes of the danger of cancer is fallacy. William Mayo says: "Leaving the cervix leaves an average cancer liability. We have seen sixteen cases of cancer occur in the left-over cervix, more than five years after supravaginal hysterectomy." (12)

E. Essen Moeller reports 700 operations for myomata followed by the development of 22 malignancies. This is 3.14 per cent. (13) On the other hand, Franque reports roentgen treatment of 200 myomata, followed by malignant degeneration of only one. This is ½ of 1 per cent. (14) Moeller operated upon 700 cases, with 22 malignancies. Franque rayed 200 cases with one malignancy. If X-ray has no advantage over surgery, Franque would be entitled to 6¼ (6.28) cases of malignancy instead of one. It is clear why he thinks "the roentgen ray tends to ward off cancer."

In the type of cases herein described, we have preferred X-ray to radium for the following reasons:

First: In fractional doses the X-ray gives time for readjustment and does not precipitate the menopause.

Second: The larger tumor is more successfully reduced by X-ray.

Third: X-ray controls a larger percentage of hæmorrhage. In the cases under consideration only one was refractory. This is less than 1 per cent failure, while radium shows 3 per cent or more.

Fourth: The danger of X-ray in experienced and careful hands is negative, while radium in the hands of the best radiologists may be followed by serious results. (15)

Fifth: Roentgen ray can be successfully applied without loss of time, inconvenience or discomfort, and without hospitalization. It is, therefore, more economical. Radium patients require an anæsthetic and should remain several days in the hospital, the same as any case of curettage. Dr. John G. Clark insists that symptoms are not safely

over in 24 hours and his patients as a rule remain in the hospital five days. (16)

Sixth: The roentgen ray covering a wider field, is more inclusive of possible pathology and better stimulates the lymphatics.

No burns have thus far marred our records. This proves nothing except that it is possible to so systematize precautionary measures that accidents are eliminated. In some states a burn presupposes neglect in the eyes of the law. No further evidence is required. It is undoubtedly true that a burn shows conclusively that some one has blundered. Our doses are carefully estimated, the filters are actually in place, the time is checked by two timers, the port of entry is closely fitted with circles of lead, each port is numbered, indicating the order of exposure. The patient is constantly under observation.

In conclusion: Why in benign gynæcologic cases has not X-ray come into the good repute that it deserves? The legitimate criticism launched at us by some of the best in the profession warrants our taking a little time for serious consideration. Surgeon-gynæcologists are not losing their opportunity to make comments from which we must learn.

A year ago this organization decided that technicians who were not licensed physicians should not be admitted into full membership. Why? Is it not true that to-day members of this Society are treating women said to have tumors, without an orientation of the organs of the pelvis, without even an attempt at diagnosis and prognosis? They simply set the machine and throw the switch. A technician could do no worse. The doctor referring the case probably did give the order for X-ray. Technicians and nurses should be limited to that order, but a physician, trained in an exacting specialty, should not take such orders unless in his judgment the case conforms to the demands of his specialty.

If members of this Society expect to compete successfully with technicians and purely commercial laboratories, they must do work that is recognizably better, and that is the only acceptable answer to our critics.

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CAVITIES OR PNEUMOTHORACES[1]

By PHILIP KING BROWN, M.D., San Francisco

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SINCE the publication of the article by Dr. M. P. Burnham and the writer (1) (*American Review of Tuberculosis,* April 1922), in which exception was taken to the interpretation by Brown, Sampson, and Heise of certain ring shadows in roentgenograms of the lungs in which there was no apparent rarefaction within the ring, and showing linear markings seen in lung fields, no proof has been offered that the exception was not well taken. The shadows had been held very generally to be cavities, but these writers contended that they were not in the lung at all but in the pleura, and were pneumothoraces. Following the original article by Brown, Sampson, and Heise (3), other authors, accepting the interpretation, followed with articles differing from the original contention only in explanation of how annular shadows were produced. Evans (4), Amberson (5), Honeij (6), Lemon and Barnes (7) and others all cite experiences in several studies and dwell upon the frequency and import of the condition. None of them offers any proof from autopsy, or any of the methods which might have thrown light easily on the question. A second article (2) by the writer deals with the proof that the contention of all the authors referred to is wrong (*Amer. Jour. of Roentgenology,* June 1923). The matter might well have been left there had not Barlow and Thompson (8) (*Hygienic Laboratory Bul. No. 132,* Sept., 1922) published a 250-page article entitled "Small Pneumothoraces in Tuberculosis," in which they accept the views of

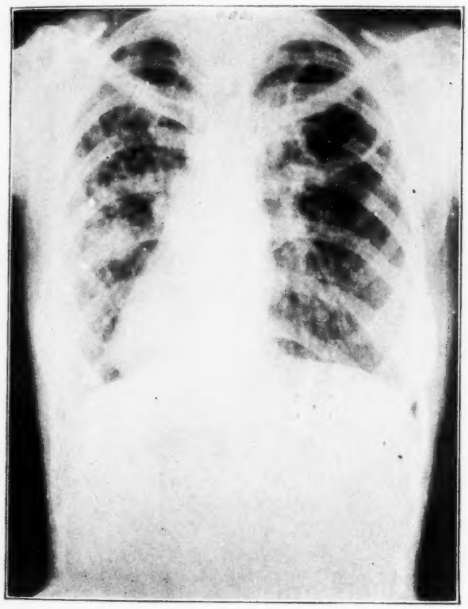

Fig. 1. Cavity answering annular shadow descripiton.

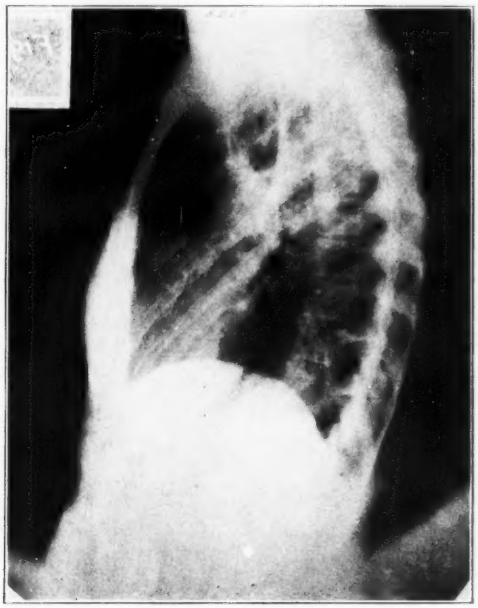

Fig. 2. Large cavity at right apex extending down far enough to show its lowest part in a lateral view. The upper part is obscured by shoulder joint.

[1]Read before the Radiological Society of North America, San Francisco, June, 1923, and the National Tuberculosis Society, Santa Barbara, June, 1923.

the Saranac School seconded by Evans and Honeij (p. 49), and add "another type of annular pleural shadow," which

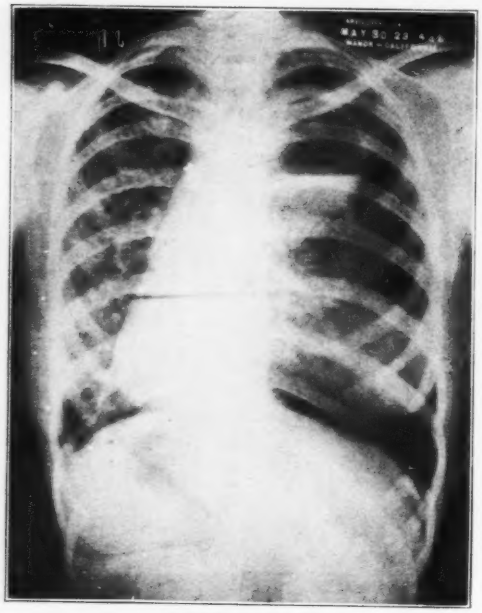

Fig. 2 *a*. Same case after pneumothorax showing by change of position that the shadow is a cavity.

they take to be formed by an inflammatory reaction in the pleura at the edge of an involved area. "This new type has a gradual shading of both the inner and outer edges, is usually less dense than the shadow caused by a pneumothorax, is not accompanied by a distortion of near-by markings and in plates taken by our technique always shows a recent pathological process in the overlying lung."

The explanation of these two types offered by Barlow and Thompson is peculiarly involved, and interested investigators are referred to pages 50 and 51 of their monograph where they have elaborated a theory upon an unproven and probably mistaken postulate on which they add still further unproven and probably false propositions. We are told that according to definition of boundary lines, pneumothoraces occur in 90 per cent of cases, while considering only as annular shadows such forms of pneumothoraces "as might be mis-

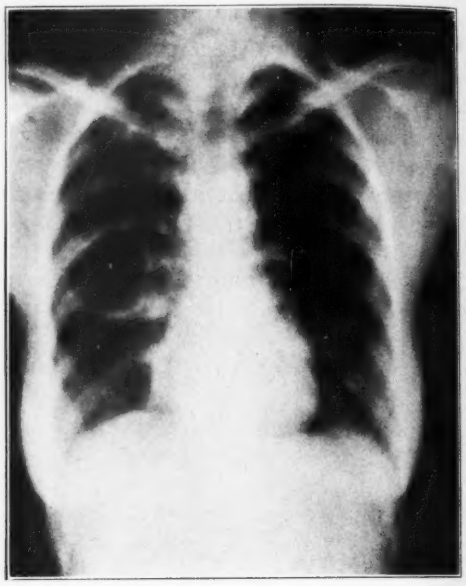

Fig. 3. Large centrally located cavity of the annular shadow type, draining into a bronchus.

taken for cavities by the unwary, they have occurred in about 8 per cent of cases." They admit the impossibility of showing "these small pneumothoraces by any of the methods of reproduction of X-ray plates in general use" (p. 9), but devote a chapter (p. 212) to their special X-ray technique. Their exposures for stereo plates vary from 3/4 of a second for a first plate on very thin patients to 3 3/4 seconds for the second plate on a very thick person. They explain further in the report of a case carefully studied before death and studied in frozen section later, that "these small pneumothoraces are not and cannot be demonstrated at autopsy."

If there was confusion before the publication of this elaborate study of Barlow and Thompson, there might easily be chaos since, as the report has the authority of the U. S. Public Health Service and the authors refer to a num-

ber of the leading authorities on tuberculosis in the country who have been consulted by them and who have "given

Fig. 4. Lateral view of the same cavity.

of their time and thought." The statement is not made that Bushnell, Krause,

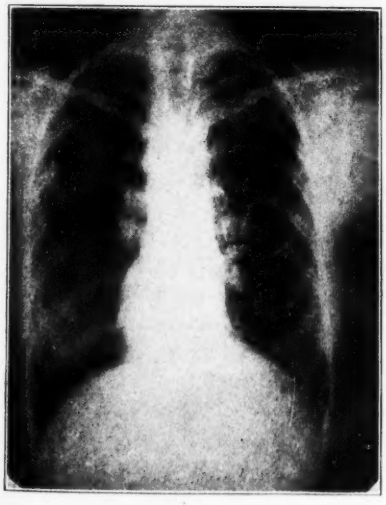

Fig. 5 *a*.

Dunham, Baldwin and others concur in the premise advanced by the writers, or agree with the theory and interpreta-

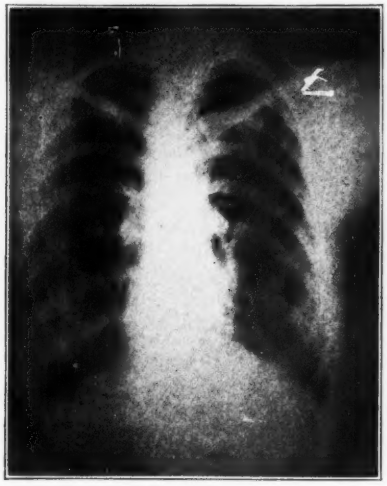

Fig. 5 *b*.

tions, but the inference is certainly suggestive. The whole matter is important because of the damage that is being done by the ready and almost general acceptance of these absolutely unproven hypotheses. If they are wrong they should be put aside finally, for to be-

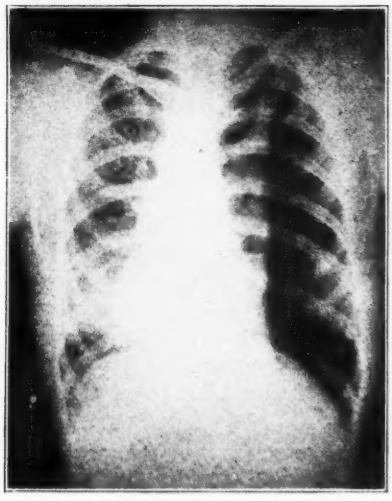

Fig. 5 *c*. Cavities showing effects of compression in changed position (see Figs. 5 *a* and *b*).

little cavity formation in pulmonary tuberculosis and reduce it to the level from the therapeutic viewpoint given tc actual and unmistakable small pneumothoraces, is to subject the patients to

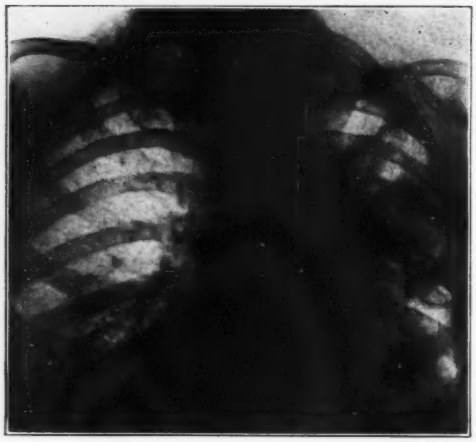

Fig. 6. Showing multiple cavitation of the annular shadow type.

dangers which will cost endless lives. That all these contentions are wrong, particularly the last one, can be shown easily by most, or all, of the following methods of investigation.

Stereograms made in a 40th of a second each give a detail and a perspective which make interpretations more accurate than were possible with the technique described by any of the writers mentioned.

(1) They show not only the exact outline of the cavities but their position, and many show even the opening of the cavity into a bronchus. (See Figs. 3 and 4.)

(2) The lateral views of these cases show the outlines under discussion to be in the substance of the lung and equally round or oval in lateral as well as antero-posterior plates. (Figs. 2 *a* and 4.)

(3) Matson has injected methylene blue into such areas and had it expectorated within a few minutes.

(4) Air introduced into the pleural cavity will compress and move the area in a way that would not be possible if it were a localized pneumothorax. (Figs. 5, 6, and 7.) If attached to the chest wall it would not move at all. If interlobar, the shape might be changed but it could not be compressed.

(5) Small artificial pneumothoraces, limited because of extensive adhesions, and early stereograms of small spontaneous pneumothoraces never look anything like the condition under discussion.

(6) If Barlow and Thompson had used a Leur syringe and a long needle with the aid of fluoroscopic direction, they would have had no trouble what-

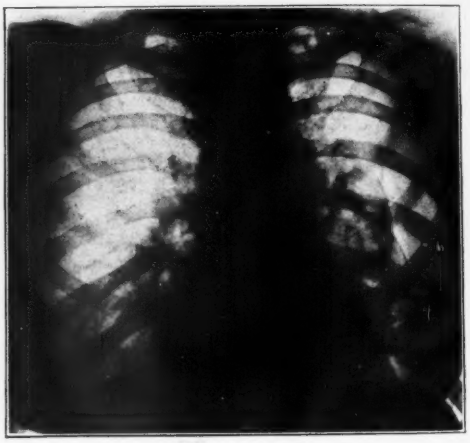

Fig. 7. Showing that all of these are cavities as the result of their changed position after the introduction of air.

ever in proving the falsity of their entire contention. It is perfectly possible to change the air contents of a localized pneumothorax and observe it under the screen, so that there should be no excuse for allowing the question of differentiation to arise without settling it by proper investigation.

In previous publications (1), the advantages of the 1/40th second plates have been discussed and it needs no argument to show the advantages in detail of such plates. Lateral views are

necessarily hard to get so that they show any but the larger annular shadows. They cannot be gotten so that they will show apex cavities on account of the interference of the shoulder joints, but illustrations of how plainly they show in the mid lung or bases are shown in Figs. 1, 2, 3, 4, and 10 *a* and *b*. These shadows answering all the description of the so-called annular pneumothoraces are certainly cavities, for they are shown to be round in two directions at

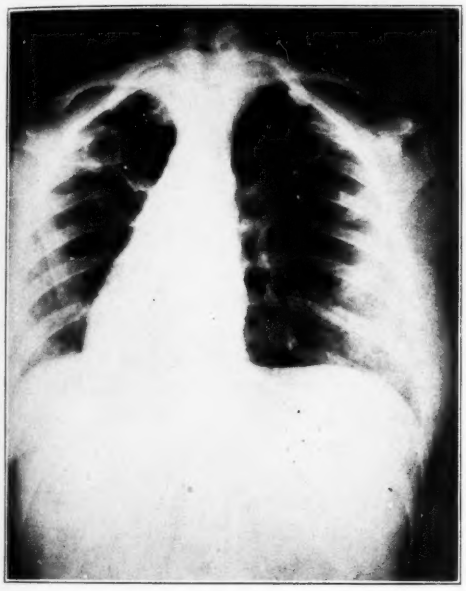

Fig. 8. Showing how much more plainly a cavity in the left apex shows when taken with the back to the plate (Fig. 9), than when taken with the chest to the plate. A cavity is seen also faintly outlined in the other apex in Fig. 8.

right angles, which would not be the case in a pneumothorax, especially if interlobar in position. From their location they must be in the substance of the lung. Matson, whose intensive clinical, X-ray and autopsy studies of tuberculosis have been masterpieces of industry and careful criticism, promptly met the pneumothorax theory by injecting methylene blue into such an annular shadow and noted that it was expectorated promptly. It would take some mental gymnastics to explain this fact on any pneumothorax theory.

The influence of artificial pneumothorax on these shadows in question in changing size, shape, and position, has

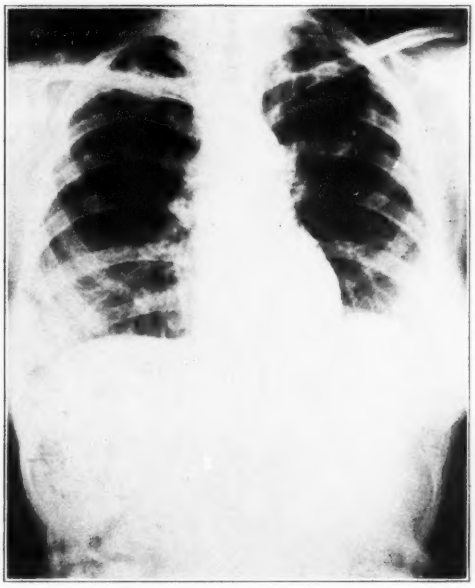

Fig. 9. See Figure 8.

been discussed by the writer elsewhere and it is necessary only to show what happens. (Figs. 2 *a*, 5 *a*, *b*, *c*, 6, and 7.) Not one but dozens of such proofs have been observed by us at Arequipa Sanatorium.

Attempts have been made many times during the past year to make even a small compression in certain cases where generalized adhesions prevented the usual compression sought for. Several cases of complete compression unfortunately had been allowed to go too long without air, and fresh adhesions bound the expanded lung to the chest wall and the effort was made to break these up. Under fluoroscopic control the needle is inserted and the manometer connection indicates when the pleural surface is reached. A negative pressure may be converted into a markedly positive pressure before a per-

ceptible amount of air is introduced. Even the turning on of air for a moment will sometimes do this. If the whole apparatus is now detached, leaving on the needle a few inches of rubber tubing which is pinched tightly, a 20 cc. Luer syringe with the piston partly withdrawn, may be attached to the tubing and a measured amount of air forced in. The tubing is again clamped,

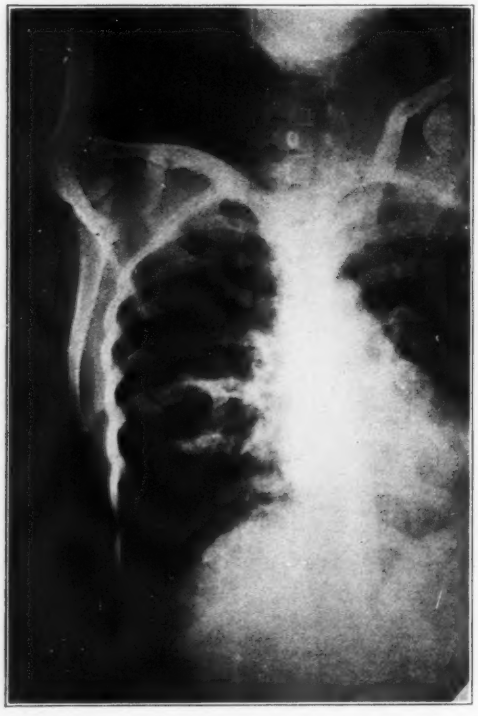

Fig. 10 *a*. Thick-walled annular shadows; antero-posterior view.

the syringe detached and the piston again withdrawn and the process of introducing air may be continued indefinitely. Pleural pains are soon set up, but generally not until 150 cc. of air have been introduced. The author has tried this in all sorts of cases and has observed in the fluoroscope the lighting up of the area where the air has been introduced. Stereo plates of such cases have never once shown an area even faintly resembling the pathological conditions under discussion. It is possible to withdraw air from an obvious, small pneumothorax by a reversal of this same procedure, and to detect movement in the wall when air is alternately withdrawn and forced in. It would be exceedingly easy to elaborate on Matson's ingenious experiment, and inject methyl blue solution into such a pneumothorax. Matson settled the problem of annular shadows in his own mind by injecting methyl blue into one and having it promptly expectorated.

There is no reasonable excuse for the Barlow and Thompson hypothesis that practically all cases of pulmonary tuberculosis show small spontaneous pneumothoraces which they claim to demonstrate radiologically, when they confess they cannot demonstrate them at autopsy, and yet they could have outlined them with bromide solution introduced under fluoroscopic control with a needle and syringe, thus making them show in plates. It seems strange that pathologists would not have called attention to such conditions were they present. At least the interlobar air-filled areas would be recognized, and while Sabourin may be right, that they do occur, they must be exceedingly rare, as almost invariably the whole interlobar fissure is obliterated if involved in a wide spread of lung or pleural process.

Barlow and Thompson have admitted that their pneumothoraces cannot be found at autopsy. In consultation with several pathologists on the subject, I find that not one of them believes that any such thing can occur. I have recently attended all the autopsies I could, in the hope of seeing anything that might be interpreted as these authors interpret annular shadows, but frankly nothing has been found that could in any way suggest a basis for their explanation.

Small cavities in the apices are sometimes difficult to picture so that their structure is clearly defined, even if their

outlines are not obscured by the clavicle, and lateral views are useless on account of the shoulder joint. In any such condition, it is always in order to turn the patient around so that the back is against the film and take exposures in that position. The clavicle shadow is practically eliminated and if it chances that pathological conditions in the upper half of the upper lobes are nearer to the back than the front of the chest,

Fig. 10 *b*. Lateral view showing two cavities.

greatly improved definition is secured. Cavities the size of a cherry stone may be made out clearly under these conditions, which might have been open to question in plates taken in the reverse direction. Figures 6 and 7 illustrate this perfectly, the cavities in question being respectively 1 and 2½ cm. in diameter, and both nearer the back than the front. The larger one might have been thought to be associated with an interlobar condition, but for the facts brought out by the picture in the reverse position, not only showing the relation of the cavity to the surrounding parts, but clearly depicting its opening into a bronchus.

The argument has been advanced that were annular shadows cavities and not pneumothoraces, they would not disappear so rapidly, and if they disappeared at all they would cause distortion from contraction commensurate with the size of the shadow. In the first place the so-called annular shadows that do disappear are very few compared to those that do not. Secondly, annular shadows proven by two-way plates to be cavities have been known to

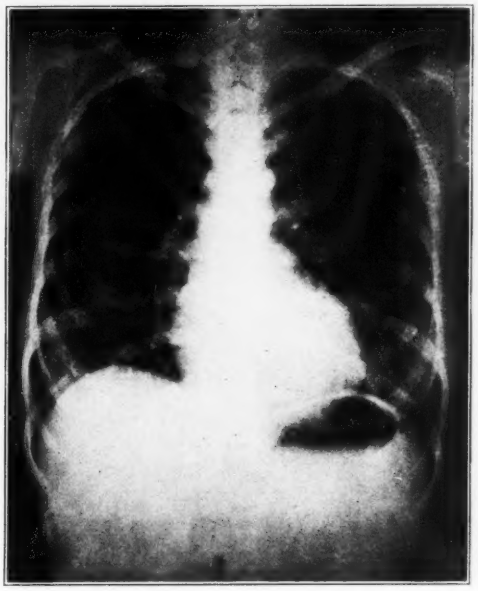

Fig. 10 *c*. Same patient 3 months later. Cavities practically disappeared.

disappear in 6 weeks to 3 months, as illustrated by two cases shown in our series (Fig. 10 *a* and *b*, and Fig. 11 *a* and *b*) and no distortion has resulted. The shape assumed by some of these cavities as they grow smaller suggests that the limiting of the excursion of the diaphragm is a large factor and this would be difficult to picture as distortion, unless extreme. Much depends also on the nature and extent of the

process around the cavity. The nature of the compensating changes that take place in lungs healed of tuberculosis is far from being completely understood. Apart from fibrosis there must be changes that account for the remarkable clearing of quite intense and extensive tubercular disease, so that plates taken some years after healing show nothing that even remotely suggests scar tissue. In a series of autopsies

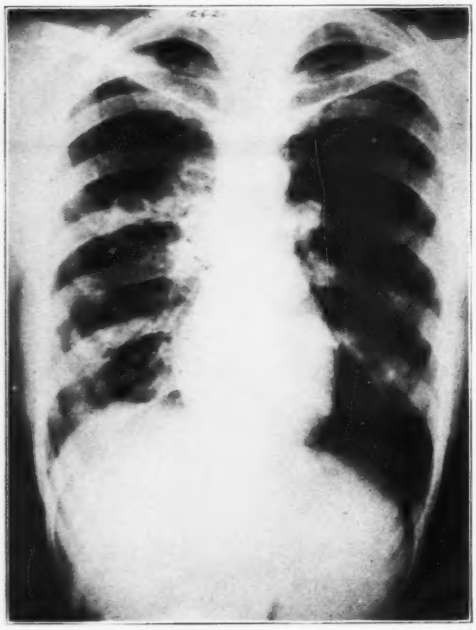

Fig. 11 *a*. Showing a cavity which disappeared within a few weeks. (See Fig. 11 *b*.)

made at the San Francisco morgue some years ago in a study of obsolete tuberculosis, white puckered pleural scars at an apex, marking an old healed tuberculous lesion, were repeatedly found where not the slightest evidence of pathological remains showed in the normal pink lung underneath. There was almost none of the so-called compensatory emphysema, which is a condition rarely seen. The lung process had healed and the only remaining evidence of trouble was the puckered, depressed, thickened pleura occasionally attached to the parietal wall.

Is the healing process an hypertrophy—a regeneration of the alveolæ? There is evidence that new formed alveolæ do occur, and I believe one of the Saranac workers (Gardner) is responsible for the proof of this fact.

Summary

Methods of studying "certain ring shadows in roentgenograms of the lungs in which there is no apparent rarefaction within the ring, and showing linear markings seen in lung fields" are presented, which, if followed, will prove that these annular shadows are cavities and not pneumothoraces. The

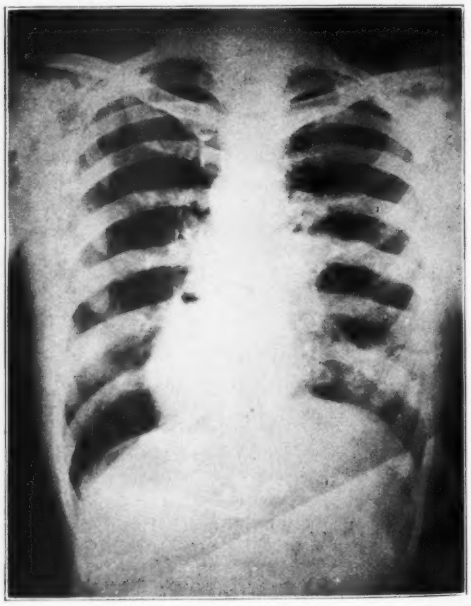

Fig. 11 *b*. See Fig. 11 *a*.

author has never yet found one annular shadow such as is described above which was not shown to be a cavity.

The dangers to the patient which will arise unless this is done, are so great that if any doubt exists, proof must be obtained of the right interpretation.

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DISCUSSION

Dr. W. W. Wasson, Denver, Colorado: I have been interested in the discussion of pneumothoraces for the last two years. I have been watching the investigators and their conclusions, but have taken no active part. I feel that Dr. Brown is quite wise in his analytic way of considering these pneumothoraces, and I think it is well to question whether they are pneumothoraces or cavities until we can prove definitely. On the other hand, I think the Saranac people have found certain evidences that warrant the conclusion that we do have pneumothoraces. The theorizing is very good but we must have the autopsy proof before we can say definitely whether any shadow is a cavity or a pneumothorax.

There is one way in which we can help our investigation of any particular case and that is by taking films at an angle. It is not necessary to take a radiogram with the patient on the face and then one absolutely lateral, but by shifting the tube at an angle from 45 degrees to as much as 90 degrees, if we have an annular shadow which is annular in three dimensions then that shadow should become elliptical or at least change its shape and diameter by shifting the tube. Using one angle and then shifting the patient again, with the patient still on the face, is helpful, and I feel that a change in the circle should take place. The chief difficulty in diagnosis in the case of annular shadow is in the first or early case. Perhaps in such a case it is of the greatest importance to the patient and, after all, it is the patient that must be considered in the final conclusions. If we have a pneumothorax in an acute case it usually means that the lung has broken through into the pleural cavity. Again, knowledge of the cases in which we discuss annular cavities or shadows show some involvement and I think we should pay a great deal of attention to the structures in the lung. Do they show cavity or a healed process irrespective of whether we have an annular shadow or not? In this investigation I think we should pay considerable attention to the structures and the shadows and not say, because we have a certain structure and a certain shadow that it means a certain pathology, but rather study the structure and the fibrosis in the lung just as the pathologist would study his slides, starting at the normal and watching it change into the pathological. We should strive to get good detail so that we can obtain actual information about the lung structure.

Dr. Philip K. Brown, San Francisco, California (closing): I think Dr. Wasson is right. If we could get before autopsy perfect stereograms of the thing we were going to see very shortly I believe we would have a contribution to the understanding of this subject that would be of great value. I am convinced that the X-ray tells as much more of the morbid anatomy of the tuberculous lung as does the autopsy tell more than the X-ray.

THE TREATMENT OF LEUKÆMIA BY IRRADIATION OF THE CHEST[1]

A Preliminary Report

By W. W. DUKE, M.D., Kansas City

IRRADIATION is a time-honored and perhaps the most satisfactory therapeutic measure employed so far in the treatment of leukæmia. The majority of patients with this disease respond to it temporarily with reduction in the white count and clinical improvement. This result is often obtained regardless of the site at which ray is applied.

It does not seem logical to suppose that irradiation of the relatively small proportion of the bone marrow in the treatment of splenomyelogenous leukæmia accounts for the marked reduction in the count which often follows, if the action of the ray were that of a direct effect upon bone marrow itself. In the first place, the relatively small percentage of marrow rayed is not proportionate to the large percentage of reduction in the count. In the second place, the marrow, situated as it is in dense bone, does not receive as much ray as do other elements located in the soft parts.

It seems probable that the benefit which actually follows irradiation is due, in part at least, to an effect upon some tissue common to all parts rayed and located in the soft parts. Blood, of course, is common to all parts at which ray has been successfully applied.

The chest is ideally suited to the application of ray to the blood. First, the lungs allow a penetration of ray that can hardly be obtained in other parts of the body. Second, there is perhaps a larger concentration of blood in the chest than can be found elsewhere in the body. The heart, large arteries and veins, and pulmonary capillaries are constantly filled with a relatively large proportion of the total volume of blood in the body. Third, the pulmonary capillaries, especially in splenomyelogenous cases, are engorged with the leukæmic cells. Fourth, on account of the large area of skin surface, blood in the chest can be rayed through a number of skin portals.

With the idea in view of applying ray chiefly to the blood (and white cells), I have treated seven cases of leukæmia by irradiation of the chest in small exposures and feel justified at this time in making a preliminary report that a very marked reduction in the white count was obtained in three of the seven cases. In the four cases which showed little response, all lymphocytic cases, I believe insufficient ray was applied.

The technique used was as follows: Spark gap, 8 inches; filter, 3 millimeters aluminum, ¼ inch sole leather; target distance, 10 inches; current, 5 milliamperes; exposure, 5 minutes (a 10-minute exposure, with the above technique is likely to give a slight skin erythema).

The count in one splenomyelogenous case was reduced, after one five-minute exposure to the front and back of the chest, from the maximum of 160,000 to 29,000 within a period of eight days, and to 15,400 within a period of seventeen days. This was associated with subsidence in the size of the spleen and marked clinical improvement in the patient. The differential count and appearance of the leucocytes showed, likewise, a marked change toward the normal. This patient was rayed a second time after a period of two and one-half months at which time the count had increased to 49,000. Within six days the count dropped to 21,200. No further treatment was given and no counts higher than 21,800 were recorded up until the time of her death,

[1]Read before the Radiological Society of North America, San Francisco, June, 1923.

as a result of pneumonia, eight months later. For detailed report of counts see table on next page.

In the second case, also a splenomyelogenous case, the count was reduced following the same treatment from the maximum of 358,000 to 37,600 within a period of twenty-one days, and to 6,800 within the following month. This likewise was associated with very marked clinical improvement as well as an improvement in the differential count and in the appearance of the white cells. Shortly after the above low count was made the patient was given benzol under the direction of her physician, Dr. Goodson, because it was difficult for her to return for X-ray. For this reason her counts made subsequently are not reported. The patient has remained in good condition, however, and up to the present time runs counts of about 15,000.

The only case of lymphocytic leukæmia which was repeatedly rayed showed a much slower rate of improvement. The original count, 118,000, was reduced to its lowest, 6,000, only after a period of three and one-half months, during which time ray was applied six times. The counts and dates at which the ray was applied are recorded below. In this case, likewise, there was a marked clinical improvement with marked subsidence in the size of the lymph glands, although the gain was much slower than in the splenomyelogenous cases. There was also marked improvement in the appearance of the white cells, although the differential count at all times showed a great predominance of lymphocytes—about 80 per cent.

Four additional cases of lymphocytic leukæmia were treated with one dose of ray to the front and back of the chest, as above described. They were each helped clinically by the treatment but showed no such response cytologically as the case previously described. It is believed that insufficient ray was applied in these four cases.

Comment

One hesitates to write upon a method of therapy based upon three successful cases. Leukæmia is not a common trouble, however, especially splenomyelogenous leukæmia, and a careful investigation of the subject requires more time. One hesitates also to suggest that the benefit derived through irradiation of the chest lies in irradiation of the blood alone, for the skin, muscles, mediastinal tissues, marrow of the ribs, and spine were rayed simultaneously as was also probably a portion of the spleen and liver. In this locality, however, the chief tissue rayed is the blood and probably during a ten-minute exposure the greater proportion of the entire volume of blood in the body is rayed. The reduction in the count observed in the two cases of splenomyelogenous leukæmia was rapid and was obtained with so little ray that one cannot help giving credit to the blood as the important factor in the result obtained.

It is justifiable to conclude, it seems to me, that through irradiation of the chest alone it was possible in three cases of leukæmia to reduce the white count to normal, or nearly normal, that this was associated with marked clinical improvement and was accomplished in two cases rapidly and with very little ray. The results were more easily obtained in the two splenomyelogenous than in the five lymphocytic cases. Also, I think it is justifiable to say that theoretically the chest should be a field of choice for the application of either X-ray or radium in this disease, for in this locality ray can be delivered more easily, not only to the blood but also to myelocytes and other white cells, than can be accomplished by irradiation of the spleen, marrow or other organs.

Summary and Conclusions

The chest offers an ideal opportunity for irradiation of the blood. In the chest is concentrated a large proportion of the total volume of blood (in the heart, great arteries, and veins and pulmonary capillaries), and in the pulmonary capillaries are lodged great numbers of white cells. Furthermore, in this locality blood can be reached easily by the ray because of the penetrability of air-containing tissues.

Of seven cases of leukæmia treated by irradiation of the chest alone, two splenomyelogenous cases which received only one exposure showed a drop in the count which was very rapid, and approached normal within eight days and three weeks, respectively. This was associated with marked clinical improvement in the patients. In the one case of lymphocytic leukæmia which was repeatedly rayed (six exposures) there was reduction in the count. The fall, however, was slow and gradual and approached normal only after a period of three months. Four additional cases of lymphocytic leukæmia which were treated by one application of ray showed clinical improvement but no marked reduction in white count. It is believed these four cases were inadequately treated.

Ray was applied to the chest for the purpose of irradiating the blood itself. It is recognized, however, that the marrow of the ribs and spine, mediastinal lymphatic tissue and a portion of the spleen and liver were rayed simultaneously.

In conclusion, I wish to acknowledge with thanks, the kindness of Drs. Tom Twyman, W. E. Messenger, W. H. Goodson, and C. E. Nixon, who referred these cases to me for study.

Blood Counts in Cases I, II, and III

CASE I, OF SPLENOMYELOGENOUS LEUKÆMIA

April	2,	1922,	160,200	Ray applied
April	3,	1922,	128,000	
April	5,	1922,	111,000	
April	8,	1922,	38,000	
April	10,	1922,	29,600	
April	19,	1922,	15,400	
May	23,	1922,	19,600	
June	15,	1922,	49,000	Ray applied
June	17,	1922,	41,000	
June	21,	1922,	21,000	
July	11,	1922,	19,600	
Oct.	18,	1922,	21,800	

CASE II, SPLENOMYELOGENOUS LEUKÆMIA

Oct.	4,	1921,	358,000	Ray applied
Oct.	14,	1921,	220,000	
Oct.	18,	1921,	168,000	
Oct.	25,	1921,	37,600	
Nov.	25,	1921,	6,800	
March	3,	1921,	24,000	Began taking benzol

Counts since March, 1921, below 15,000

CASE III, LYMPHOCYTIC LEUKÆMIA

Dec.	29,	1922,	118,000	Ray applied
Jan.	2,	1923,	101,400	
Jan.	5,	1923,	85,600	
Jan.	12,	1923,	117,000	
Jan.	19,	1923,	88,600	Ray applied
Jan.	24,	1923,	67,400	
Jan.	31,	1923,	49,600	
Feb.	2,	1923,	33,400	Ray applied
Feb.	9,	1923,	46,400	Blood transfusion
March	2,	1923,	58,200	Ray applied
March	9,	1923,	43,400	
March	19,	1923,	31,200	Ray applied
April	3,	1923,	16,000	Ray applied
April	18,	1923,	6,000	
May	4,	1923,	8,400	
June	20,	1923,	8,000	

DISCUSSION

Dr. H. H. Bowing, Rochester, Minnesota: In treating the myelogenous and splenic types of leukæmia with our technique we use radium to the splenic and glandular enlargements in leukæmia, and also support this with X-ray to the long bones in myelogenous leukæmia, for the reason that you cannot bring about a destruction of all the my-

elogenous cells in the circulating blood with irradiation to the glands and spleen alone. It seems that bone tissue plays a part in the production of the myelocytes, and it is necessary to ray the long bones if you are going to have a complete effect upon the myelocytes circulating in the blood. In the splenic type the long bones should not be irradiated at all, since the radium or roentgen rays applied to the splenic or glandular enlargements is sufficient for satisfactory remission. There is an early case reported in which the spleen was removed in a leukæmic patient to be followed by a recurrence of the leukocytosis, and then the splenic area was treated with radium and the white cell count was reduced and the theory advanced was that it was probably due to raying the circulating blood. In the myelogenous leukæmia I think it is necessary to ray the long bones as well as the other lymphoid enlargements.

Dr. Robert R. Newell, San Francisco, California: I am tremendously interested in the treatment of leukæmia and am more pleased than I can say with Dr. Duke's statement that the effect is due to the treatment of the blood rather than to one part of the body. I am also pleased to hear his remark about the small dose of X-ray. I think it is wonderful to see that we can give one treatment and have the patient back on his feet within a few weeks, which is what occurs in many cases. One becomes superstitious about his dosage and when he sees a miracle occurring under his fingers, how would he dare change his technique in the next case with the same diagnosis?

We have been using 5 milliamperes with 9½ inch spark gap, 5 millimeters of aluminum and a 12 inch target distance for 3 minutes, directly over the spleen once a week. I have seen the white cells in several cases drop from several hundred thousand to normal within one week after the first treatment, showing that massive dosage is not necessary.

I would like to take exception to the theory that treatment of the long bones is a necessity. I have seen cases with a good many myelocytes in the blood clear up so far as the myelocytes were concerned, even in one infant who died two months later. The leukæmia never came under control, although the white cells kept under 9,000 and were often as low as 4,000. In that case there was 4 or 5 per cent of myelocytes and after treatment the myelocytes did not recur until the terminal exacerbation.

I wish Dr. Duke would tell us again his dosage and also in regard to the frequency of treatment. We feel that once a week is the proper frequency and that the patient should never be permitted to get away from X-ray treatment the rest of his life. So many of our patients have done badly after having a vacation from treatment.

Dr. W. W. Wasson, Denver, Colorado: The blood seems to be very sensitive to the X-ray. I had the pleasure of listening the other day to a paper by Dr. Sabin on the blood in which she showed that they were able to keep the cell alive and motile for five hours normally and under X-ray stimulation for twenty-four hours, so the blood seems to be very sensitive to the X-ray.

I should like to have Dr. Duke tell us what he thinks in regard to McCallum's work on the blood, in which he describes and speaks of the leukæmias, myelogenous and otherwise, as cancer of the blood. In his classification he says that we will have just as many diseases of the blood as we have parts of the body forming blood, and I think that is true. These cells are thrown into the blood from the various locations just as we have metastases from malignant tumors, and the spleen is supposed to exercise some control. If so, and if

we are to get any sort of permanency in our cures, then we should consider the location, just as Dr. Bowing spoke of raying the long bones in our treatment of these cases. We must stop the division at its source in order to get any sort of permanency.

DR. ALBERT SOILAND, Los Angeles, California: For some reason we see a great many cases of leukæmia in the South. Whether they come to escape the severe winters in the East I do not know, but we have treated a great many of these cases in the last few years. I think it makes little difference where you apply the X-ray in either type. It seems we must keep them under observation continuously and the small dose is the method of selection. The best places we have found for the treatment are the axillary and inguinal regions. We try to divide the skin up so that we get as many ports of entry as possible over the whole body, and in some instances where we have tried to use the deep therapy we have killed the patients. Two patients have died within the last few months because of the high voltage, after having received the low power treatments for several years.

DR. W. W. DUKE, Kansas City, Missouri (closing): I wish to express my appreciation of the discussions of this paper. I do not know that I have made myself altogether clear concerning my aims in carrying out the work reported. My aim was not to discover at this time the optimum dose of ray but rather to discover, if possible, the smallest dose which would have a material effect upon the blood count. The blood count in splenomyelogenous leukæmia can be materially reduced by one relatively small dose of ray. I do not believe that this would apply to all cases, but the fact that the count was so markedly reduced in two cases by a small dose would indicate the need of care in dosage in every case until the effect of the ray on the individual is tried out. I am sure that in some of our cases the amount of ray given was too small to have the desired effect. I rather believe the logical method of treatment is, first, to give a small dose and note its effect. If no material reduction in the count is observed within ten days, the same dose could be repeated and in case this is not effective, more ray through a greater number of skin portals could be tried.

In this paper I have carefully avoided the use of the word "destruction." It seems to me almost beyond the realm of possibility that the small amount of ray given in these cases could directly destroy the leukæmic cells. One must bear in mind that the blood is in the chest only a short time and that the larger portion of blood could not have been exposed to the X-ray for more than a few minutes. The action of the X-ray on the cells, it seems to me, must have been indirectly through some agent unknown at the present.

It seems to me to be impossible that the good results which have been obtained in the past in the treatment of leukæmia through irradiation of the bone marrow and spleen could have been through any direct effect of the ray upon the bone marrow or spleen themselves. It is illogical to suppose, for example, that the raying of 50 per cent of marrow in the body could cause a 100 per cent reduction in the blood count if the effect of the X-ray were on the bone marrow direct. Surely, of the effect were upon the bone marrow, the irradiation of 50 per cent of the marrow should cause only a 50 per cent reduction in the blood count. The therapeutic result must have come through the irradiation of some other tissue, and the blood, it seems to me, is the most logical tissue to suspect. In irradiation of the marrow over a prolonged period of time, I should think a rather large proportion of the blood would be exposed, though not so in-

tensely exposed as can be obtained through irradiation of the chest.

I would not like to venture an opinion of my own concerning the question as to whether leukæmia is related to malignancy. I have heard such authorities as McCallum and Wells state that this seemed likely. Concerning the behavior of the spleen, I would say that in the cases which responded well to irradiation the spleen slowly reduced in size. The spleen was greatly enlarged in only one of the cases.

A METHOD FOR TESTING THE ACCURACY OF TIMING DEVICES

By W. WALTER WASSON, M.D., DENVER, COLORADO

AT the Chicago annual meeting in December, 1921, I reported a simple method for testing the accuracy of any timing device. This method was first called to my attention by Mr. A. G. Magnuson, and inasmuch as inquiries have been made concerning it, I wish to describe it more in detail.

There is no expense involved in the apparatus, no time consumed in making

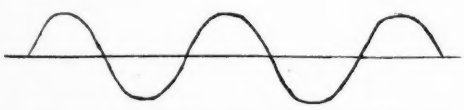
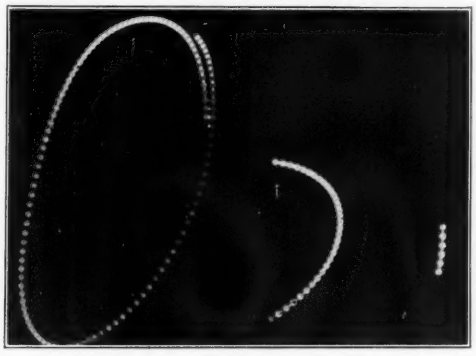


Diagram I. Single phase alternating current.

the tests, it is quite accurate and would enable an essayist to report the time of any exposure before our audiences with certainty. One speaks of the exposure time without ordinarily being more than reasonably accurate, and it is hoped that this method may enable us to standardize exposures as used among roentgenologists in various sections of the country.

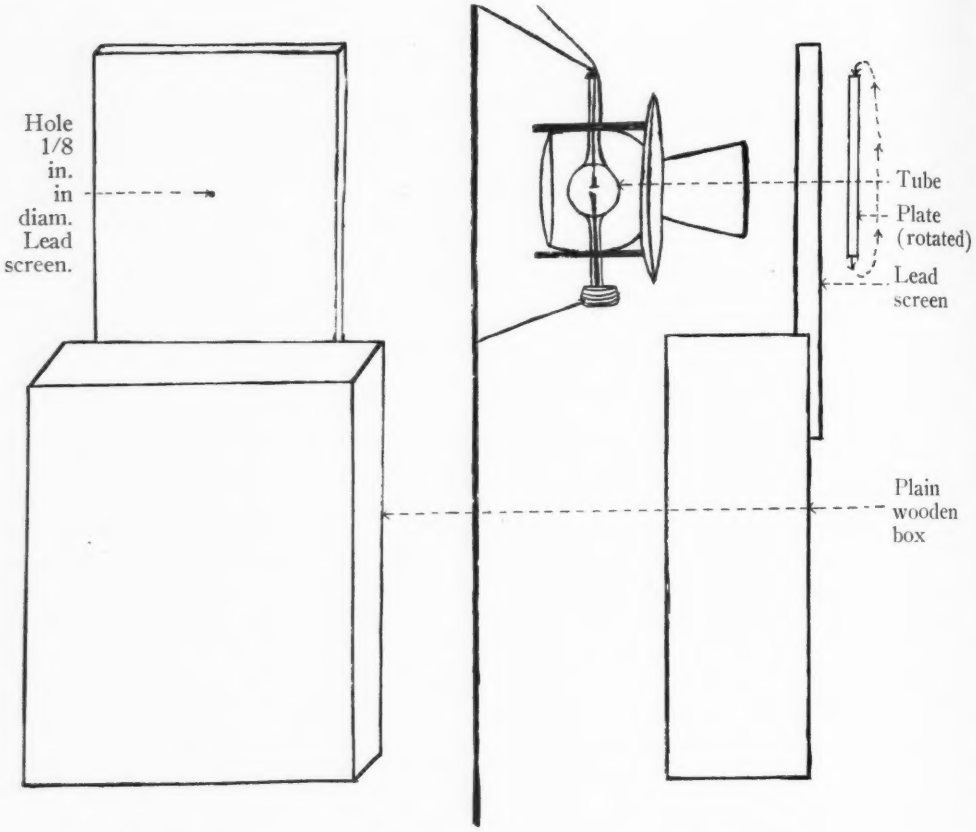
The principle is to utilize the impulses of the current; *i. e.*, a 60 cycle single phase alternating current when rectified has 120 impulses, or makes and breaks. (Diagrams I and II.) If a plate is then rotated behind a lead screen with a small opening, during one second's exposure we will get 120 dots upon that plate when developed. This is illustrated in Diagram III. A piece of lead is tacked to a wooden box. In the center of this sheet of lead is a small opening ⅛ inch in diameter. The tube is placed at the regular distance from the plate with the usual cone and diaphragm. The current as used during any exposure to be tested is passed through the tube for the time of that exposure. A film in a cassette is rotated by hand behind the lead screen. The speed of this rotation must be sufficient to separate the dots of

Diagram II. Current as above, rectified, showing 5 impulses.



1 sec. 1/4 sec. 1/20 sec.

Fig. IV.



Front View Diagram III Lateral View

exposure, and may be learned after one or two trials. The film is developed and a certain number of dots representing the makes or impulses of the exposure, separated by spaces, representing the breaks, are produced. If the exposure was exactly one second there would be 120 dots when using a 60 cycle current. If we find 40 dots, the equation is 40/120, or 1/3 of a second. (Illustration IV.) It is essential to put the usual current that is used during any exposure through the tube, as timers may vary according to current used. Other conditions should be the same as during the ordinary exposure. The operator can learn the character of his current supply from the city electrical engineer. Various modifications of this method may be used, but this has seemed to be the simplest for the ordinary tests.

DISCUSSIONS OF PAPERS

Discussion on Papers by Drs. Louis K. Poyntz and Rollin H. Stevens[1]

Dr. Benjamin H. Orndoff, Chicago: High voltage in the treatment of breast malignancies has not proven so favorable as in its use in malignancies located elsewhere. From the standpoint of technique we are inclined to reduce the voltage and use larger fields.

There are but few cases of breast cancer where radiation alone should be instituted. Diathermy and electro-thermic coagulation are frequently valuable adjuvants to therapeutic irradiation. Surgical intervention leaving exposed areas beneath the site of the malignant breast, as advocated for many years by Dr. Emil G. Beck of Chicago, offers a most satisfactory field for irradiation and gives results not otherwise possible.

The microscopic study of malignant tissues and the surrounding structures represent a field, the importance of which cannot be overestimated. Not only the histological characteristics of the malignant cells but the study of vascular supply to these tissues seems especially important.

It is probable that the principal effect of irradiation upon which we may depend for favorable tissue reaction is interference with the blood supply to certain areas and the normal tissue response to irradiation. The microscopic study of radiated malignant cells seems to show some quite significant changes, but it is more than probable that the most favorable change which retards or prevents further growth or continued existence of cells of a malignant character is due to the antagonistic or immunizing activities of the tissues surrounding the malignant areas.

I do not think it is possible to administer a dose which will kill cancer cells in the breast without doing irreparable damage to the surrounding normal structures. Therapeutic doses should be directed with a view to securing the greatest normal tissue response and at the same time inflicting all possible damage to the malignant cell. Large doses of highly filtered radiation seem irrational and are clinically inadvisable.

Experimental data are rapidly accumulating which seem to indicate that organo-therapeutic cancer immunization is a field from which we may expect much in the near future. I have recent communications from unpublished experimental work now in progress which seem more than hopeful.

For the relief of post-radiation sickness (Roentgen kater) the administration of various salt solutions has been advocated. My experience indicates that very little can be expected in this regard. I do believe, however, that injection into the tissues, not intravenously, of sodium chloride or other saline solution and even anti-cancer serum inoculations are valuable, both in preventing post-radiation sickness and in promoting favorable response against cancer invasion. It seems that pre-operative radiation, electro-thermic coagulation, surgical diathermy, autolized cancer inoculation, sterilized cancer grafts, interstitial serum cancer inoculation and the introduction of many other foreign substances into the patient's tissue may all depend for a large part of their therapeutic value upon the response of the patient's normal tissues to the foreign substance liberated or introduced.

Dr. Edwin C. Ernst, St. Louis, Missouri: I certainly feel fortunate in having had this opportunity of listening to the excellent papers presented by

[1]Papers printed in Radiology, Sept., 1923, pp. 24 and 16, respectively.

Drs. Poyntz and Stevens on the treatment of breast cancer.

The therapy of this condition has been one of our many big problems, having passed through a series of what might be termed "kaleidoscopic" changes in the method of attack. Various new techniques have been frequently suggested and described. Radical changes were found necessary with the advent of higher voltages and different filtrations, such changes largely depending upon the favorable or unfavorable biological results obtained in the treatment of these malignant diseases.

The question of immunizing the patient and the surrounding tissues and lesions to the rapid invasion of these cells into the normal structures of the human body, has been both frequently advocated and discarded. However, at the present time our attention is again directed to the activating effect of these lethalized cancer cells following radiation therapy, and perhaps it does seem somewhat more promising.

Many of you no doubt have read the experimental data of our American and Continental observers relative to the transplantation of irradiated cancer tissues upon the same animal. However, it has been a privilege to listen to the temporary results and methods employed in transplanting human cancer tissues, after thorough radiation, into the same human body. The latter experimentations are vastly more important for our consideration.

Over-radiation or second degree skin erythemas have in many cases been productive of poor results, and it seems to me, therefore, that it is very essential to study carefully the administration of the correct dose applicable to the local lesion and the individual patient in the treatment of all of our breast cases, since they are all very sensitive to the different types of radiations.

The question of preference as to the application of a single filtered dose over a given area to the divided dose method extending over a period of a week or ten days,—that certainly does not seem as important to us as the question of proper filtration of these X-rays of a standard voltage. We must avoid possible injury to the deeper lung structures in most of our breast cases, but at the same time likewise produce the desired superficial intensive action at the site of the breast lesion.

Pre-operative breast cancer therapy has been favorably discussed by the essayists and, therefore, will not require further emphasis.

The irradiation sickness syndrome in our experience has not been solved. Every attempt made by us to avoid this undesirable phenomenon has been accompanied by failure. We regulated the diet, cleansed the alimentary tract, fed our patients lots of salt and fresh air, and in a few cases employed saline solutions directly into the circulation; but could not observe a decrease in the post-radiation sickness.

Therefore, summarizing the most important points discussed this afternoon we might, first of all, emphasize the advantages of pre-operative radiation in breast cancer as being essentially desirable in the majority of these malignancies. Secondly, that post-operative radiation is essential in practically all cases, but more especially in those breast conditions in which the axillary or supra-clavicular glands are definitely involved, even though they are not removed surgically.

The better results depend largely upon the quality and amount of radiation reaching the diseased tissues. The essentials of a given dose are equally dependent upon certain physical facts, and we believe that it is most desirable to avoid over-radiation as well as over-filtration of the rays employed in any given X-ray dose in the treatment of breast cancer. In many cases four millimeters of aluminum as a filtering

material may be superior to one millimeter of copper as employed with the higher voltages, especially when the lesions to be treated are moderately superficial.

A radium pack in the axilla, in addition to the usual X-rays employed through the anterior and posterior chest walls, has been employed by us in nearly every case of breast cancer. The one millimeter brass filtered radium pack is placed within a bandage roll high up in the axilla at a skin distance of from one and one-half to four centimeters until a slight skin erythema is produced.

I think the question of the future treatment of these conditions may in a measure depend upon the immunizing changes brought about by the radiation of the affected and surrounding areas of the lesion; killing the individual cancer cells in such a manner as to produce these supposed desirable enzymes, and this new phase of radiation therapy, as reviewed by Drs. Poyntz and Stevens, may in a measure prove to be of additional value in the treatment of breast malignancies.

Dr. John F. Herrick, Ottumwa, Iowa: I wish to say a word on the subject of the liberation of "something" in the system as a result of X-ray treatment. Some years ago an Edinburgh physiologist proposed the hypodermic use of trypsin and amylopsin in the treatment of cancer. Under this treatment patients were for a time markedly improved, only to relapse later. The discharge was very much less, the pain decreased, the blood would build up, the appetite return, and for two to four weeks everything looked favorable. A similar result seems to follow X-ray treatment. It is encouraging to know that competent men with proper facilities for work are trying to learn what the factor is that so markedly improves but does not cure the patient.

My experience has been almost exclusively with fractional doses using from 4 mm. of aluminum to ½ mm. of copper as filter. For the present this method appeals to me more than the one large single dose.

Dr. Henry Schmitz, Chicago, Illinois: We have seen quite a large number of these cases and I wish to call your attention to a few facts we have observed. It is probably known to you that the growth of malignant tumors is not due to an increase in the avidity of the cancer cells but to a loss of avidity of the host. In other words, patients suffering with cancer have lost something which protects the ordinary person from carcinoma. Kaminer states that the blood of the cancer patients will not digest cancer cells. If the blood of a normal person is taken and cancer cells are added, the cancer cell will be digested. In other words, the serum of normal people contains properties that are absolutely lacking in people suffering with carcinoma. It has been disputed that this observation can be used for diagnostic purposes. On the other hand, we took a large number of patients and found, with the Freund-Kaminer test that the patients re-acquired carcinolytic properties after irradiation. We have continued this test in about thirty-five consecutive cases so far.

As far as the dosage is concerned, I wish to state that we have not rigidly adhered to the high voltage therapy in carcinomata of the breast. We feel that in these cases the growth is superficial and not deep, as in cancer of the uterus. If we use the 200 KV. highly filtered rays, fewer rays are absorbed in the breast cancer than in the body tissue. So we are using the old method. Depending upon the size of the breast, we use ¼ or ½ mm. of copper filter with 140 KV. mm. Also in every case we advise surgical removal of the

tumor as soon as the patient can be safely subjected to an operation. We feel that surgical intervention with pre-operative irradiation gives the patient a better chance than surgery or radiation applied alone.

DR. ALBERT SOILAND, Los Angeles, California: I think these two papers are the most advanced and harmonious papers I have ever heard. I do not believe we can add much to what has been said, but one question comes up. Of course, we are all agreed that pre-operative irradiation is perhaps better than post-operative, but now comes the surgeon and he says that if we give the patients pre-operative irradiation they bleed so profusely at operation that he cannot stop the hæmorrhage, and when we use radium for a long time it produces so many adhesions that he cannot get the tumor out. I think we will have to find a surgeon who can. I have never seen the hæmorrhage they claim from pre-operative raying.

DR. JAMES F. PERCY, Los Angeles, California: I had about decided that I would wait until next year before discussing this subject, but Dr. Soiland's remarks lead me to take it up at this time.

Last week I lost three patients from hæmorrhage following the application of my heat technique, who had had pre-operative irradiation. I am in a very good position to discuss this subject because practically all patients who come to me for operation have had radium, deep X-ray therapy, the Abrams treatment, or Christian Science. It is true that the majority of the patients who died had their deep therapy weeks or months previously, and I know that the trained X-ray therapist insists that surgery should be applied not later than a week after the use of intensive therapeutic radiation. But I wish that there was some way of avoiding the use of radio-active agents until I have finished with the surgical use of my hot knife. When the knife, fortified with heat, is employed there is but very little, if any, danger of stimulating the malignancy or of vaccinating it into new areas, as is true when the cold steel knife is employed. There is then not the use for pre-operative radiation, such as may exist where the cold knife is the instrument used.

It is too early to make positive statements for or against pre-operative radiation, and this explains my reluctance to discuss the subject at this time. Next year I believe that all of us will be in a position to make more accurate statements. But when I lose three patients in one week who have been previously radiated, it makes me nervous and, besides, plays hob with my operative statistics. They bleed early and late and you cannot stop the hæmorrhage. It is much like punching a hole in a tin can filled with water, or, better perhaps, corresponds to a "fountain filled with blood." The blood vessels have lost their character, are lifeless and stick out like fire hose at a fire or like clay pipe stems. They just leak blood. You cannot clamp vessels in that stage of degeneration because they are stiff and hard and break off and the ligature therefore is useless.

I am not in a position to say, at this time, I repeat, that pre-operative radiation has no place in the treatment of malignancy, but I wish that the radiologist could find some way to help the surgeon avoid the operative and postoperative hæmorrhages that are now so common and so extremely dangerous.

The papers read and the discussions so far at this meeting have given me much satisfaction. Everything said indicates that we are all thinking seriously along the same lines about the problem of the best treatment of the various types of malignant disease. No one has made any very positive statements

and that is wise, because no one is in a position, at the present time, to talk dogmatically on the treatment of cancer.

Unfortunately, there are many men who make statements to their patients that they would not make in one of these meetings. Frequently these men do not know even the elementary physics of the wonderful agent that they are using and they do not seem to fully appreciate that there are angles and currents and fogs that have not been understood.

A most discouraging experience is to have a radiologist insist that I will find no active cancer cells in a mass which he has fully treated but which continues to grow, and the patient insists that something more be attempted for his relief. In a recent case of recurring cancer of the submaxillary gland the radiologist reported that he had given all the intensive radiation that the tissues would stand, but the mass continued to grow uninterruptedly, invading the floor of the mouth, the tongue, and the cheek. I was assured, however, that I would find no active carcinoma cells. But when that mass was removed with my cautery knife the pathologist reported that the tumor had not been influenced in a destructive way by the buried radium emanations combined, as they were, with intensive X-ray treatment. The growth was extremely active everywhere.

Another case was one that started as a Paget's nipple. The woman was immediately subjected to a full course of intensive deep X-ray therapy by a well trained and thoroughly honest radiologist. He told this patient that if he was ever warranted in guaranteeing a cure it was in a case such as hers. This patient was referred to me by a surgeon three weeks after she had completed her intensive X-ray treatment. Her breast was then a solid mass of carcinoma, absolutely fixed to the ribs, and it had grown enormously in the three weeks. In addition, she had developed a streak of metastases in the skin that was rapidly extending toward the opposite breast. All of this developed immediately following the intensive X-ray treatment of a simple Paget's disease of the nipple.

A radiologist of national reputation told me recently that only 25 per cent of his treated cases showed improvement following the deep therapy technique. But I seem to have referred to me many of the 75 per cent, and when I treat them with my cautery they bleed and, too often, die.

So, I repeat, I am not now enthusiastic about the pre-operative use of the X-ray as a means of influencing the final results in the treatment of cancer.

Dr. L. K. Poyntz, Portland, Oregon (closing): It is very gratifying to have listened to the discussion that these papers have evoked and I wish to thank the various gentlemen who have contributed in this way. Among other points that have been brought out and which should be further emphasized is the fact that "deep therapy" is not necessary for superficial or semi-superficial conditions. Heavy filtration is not necessary when one wishes the effect near the surface, as in breast conditions. The physics of the thing is absolutely wrong as it is the absorbed energy that actually produces the biological effect that is hoped for.

Dr. Percy has spoken of three cases that died. I could cite many more than three cases, regardless of the method employed. We have not claimed or made any pretense at even assuming that radiotherapy is a cure-all or even a sure cure for any certain ailment, but what we do believe and do wish to iterate and reiterate is that we have secured results that are at least encouraging by what Ewing has described as

"the first rational treatment of cancer ever devised."

Dr. Rollin H. Stevens, Detroit, Michigan (closing): I was interested in hearing what Dr. Percy had to say in regard to bleeding from operation after X-ray treatment. I have treated many of these cases with a voltage of about 100,000 before we had the high voltage apparatus, and two or three surgeons told me they had very much less bleeding at operation in the cases so treated than they ordinarily had in breast operations without X-ray treatment. These cases were treated about three months before operation; they had three series of treatments before they were operated upon and the surgeons told me there was much less bleeding than usual. I think there is a great difference, however, in the action of the moderate length wave and the modern short wave therapy upon the skin. There is a vast difference in the condition of the skin after the two methods of irradiation. We have as yet heard no complaint from surgeons who have operated upon cases that were treated thirty to ninety days before by the ray produced by 200,000 volts. Cases like the three mentioned by Dr. Percy may not happen again for a long time, and the bleeding may have been due to other causes.

Discussion on Paper of Dr. Henry Schmitz[1]

Dr. Albert Soiland, Los Angeles, California: This paper of Dr. Schmitz's is perhaps one of those which we like least to hear, and yet it is one of the things which is brought home to each of us who has done any amount of irradiation. When I open my morning mail I always look at the envelopes to see if there is a letter from some attorney, for people have become educated to the fact that the radiologist is a fertile field for remuneration. However, that does not exonerate us when we injure the skin. With our present knowledge of the physics of the thing there is no longer any excuse for injuring the skin, but we are taking a chance with every patient we treat. I make this statement in spite of our knowledge of the skin and of the X-ray measurements. We can measure everything under the sun but the human animal. As a rule we can strike an average which is reasonably safe, but with that knowledge we must remember that the patient will come, upon whom you will apply a safe dosage and yet that particular patient will develop, within a few months or a few years, a radiation injury. I hope we will all take Dr. Schmitz's paper very much to heart because it gives us information which we must always bear in mind. As Dr. Schmitz enumerated the various forms of treatment he has used, for the most part unsuccessfully, it shows that there is no real treatment for X-ray burns. We have to treat the individual; if the condition can be removed surgically that is the thing to do. That is the quickest way out of the mess. The medical treatment is merely palliative, useful in some cases but entirely useless in others.

Our present-day knowledge of the question of irradiation is of considerable help in that we do not now see the bad cases of radiodermatitis that we saw several years ago. There is always the possibility of the delayed reaction and that I am unable to explain in any way. This thing was brought to my mind in a patient I saw just two days before leaving home for this meeting. That patient was treated for uterine fibroid some eight years ago by a man who was careful and knows his business, and yet that patient developed a dermatitis and bad necrosis of the skin eight years later. It is the typical case of pigmentation which remains eight years after the treatment and in that mass of pigment is the telangiectasia

[1]Paper printed in Radiology, Sept., 1923, p. 34.

and the ulcers which can only be treated by the surgeon. That is the longest period between treatment and effect that I have ever heard of. We have a patient in our office who was treated two years ago with a small skin applicator of radium. She has two punched-out square ulcers 1 cm. deep just about the size of the applicator. They are painful and can be relieved only by surgery. These things must be kept in mind, but I think this should not deter us from our efforts to make use of these agents, for the longer we use them the better we will know how to handle them and the more infrequent will be these accidental conditions.

Dr. Roy W. Fouts, Omaha, Nebraska: The successful treatment of X-ray burns necessitates a knowledge of the underlying cause. The primary cause was exposure to radiation, but underlying,—the thing that really causes the burn,—is the fibrosis and the cutting off of nutrition to the tissues, resulting in a necrosis due to completely cutting off the blood supply. We have not cured an X-ray burn when we have caused it to granulate and heal. If we do cure we must relieve this necrosis and endarteritis. I have a case that came in just about holiday-time with a third or fourth degree burn, between seven and eight inches in diameter, circular, across the back, which was caused by one of the bedside units which the physician had just installed and with which he thought he would do some intestinal work. Without any fluoroscope he backed his patient up and stood him there, using a hand fluoroscope,—he did not know how long. Within three weeks he got his vesiculation and an ulcer which healed, or almost dermatized over. In October it began to break down and in three weeks there was the circular ulcer, seven or eight inches in diameter. He was suffering intense pain and had been unable to sleep for ten days. I was called to the hospital in the evening after his admittance to look him over and see if any relief could be obtained so that he might sleep.

It is true that we formerly thought we had no treatment for X-ray burns, as Dr. Soiland has just stated. I had been using the actinic light for about a year and decided to try it in this case. The entire area was necrotic and it was only with difficulty that any one could remain near him because of the odor. I took him down and gave him a five- or six-minute exposure to the actinic light at a distance of about eight inches and he stated the next morning that he had had the best night he had had for weeks. I continued that regularly for some weeks and after a little while gave him light doses of X-ray, because we know that light doses do favor the absorption of fibrosis. In addition, I gave him diathermy and heated it up thoroughly. The sloughing continued for some time, the fascia sloughing most. The muscle tissue seemed to stand up better but the fascia sloughed until two of the tips of vertebræ were exposed. At the lower end of the burn the fascia sloughed underneath the skin. The result of this treatment is that today the ulcer is less than two inches transversely and perhaps three inches up and down. The patient has been without pain practically all the time since a short time after the institution of treatment. He is doing well, looks well, and perhaps with good luck I will be able to get him out in a year or such a matter.

I do think we should bear this in mind, for I believe we have a wonderful agent here. In a case in which I was giving the deep therapy by mistake, when I thought I had given him the maximum dose which I intended to give, which was 720 ma. hours, I gave him another dose over the same area. I took him right off the table and put him on the actinic ray and kept him for

three weeks. I bronzed him good and brown with the actinic ray and have not had a moist skin to date. I know, however, that we get latent burns and will not feel safe about him until he is dead, but I know we have an agent in the actinic light that every man should bear in mind and provide himself with. I have noted that the skin does not become as leathery as it formerly did and I am combining actinic with deep X-ray therapy.

DR. HENRY J. ULLMANN, Santa Barbara, California: I would like to know whether the burns resulted with a copper filter or whether an aluminum filter was used in all the cases.

DR. JAMES F. PERCY, Los Angeles, California: This paper covers an exceedingly practical subject, and I want to tell you what I believe to be the most promising form of treatment, because I have had a rather abundant opportunity to study and to treat the condition under discussion.

The pathology underlying all of these trophic burns and ulcers is a chronic endarteritis obliterans combined with a progressive fibrosis of the involved tissues. As long as these factors remain, and in the majority they persist almost indefinitely, the wound will not heal. It is this condition that accounts for the often atrocious pain that endures for so long in the irradiated areas which are involved in this particular process of destruction.

Normal human tissues have not had time to develop a method of repair following the damage resulting from the use of the X-ray, radium or high frequency currents. This is the explanation of our inability to successfully treat skin graft wounds resulting from radioactive substances or the ruinous tissue effects of explosive shells. The grafts will not take until the fibrosis and endarteritis are eliminated.

On the other hand, normal human tissues for untold generations have been mastering the injuries produced by ordinary fire, and they have learned to heal that kind of injury and do it very well under the ordinary and well-recognized methods of treatment. But with the trophic wounds under discussion the problem is entirely different.

I have found that all of these wounds can be made to repair if these damaged anatomical regions are first dissected out with my heavy cautery knife. Following this, these wounds suppurate freely, and this is permitted to continue for ten days or two weeks. This encourages the remaining tissues that have been acted upon by the cautery to slough away, leaving a healthy granulating surface that can be cleaned up by the application of the Carrel-Dakin solution. When this is accomplished the surface is ready for covering with Thiersch grafts. But the successful management of these degenerated areas does not end here. As soon as the grafts are well established in their new location they should be, at first gently, and later vigorously, moved (massaged) by the application of pressure from the normal skin toward the grafts. This should be done at least once a day, and results in the development of a much better type of repair.

We have always made the mistake of treating these newly formed tissues as delicate pieces of Dresden china. You cannot develop a type of tissue that will grow well unless you make demands on it in the way of repair that are insistent and sustained, and the most effective way of doing this is to manipulate it indirectly and later directly. In other words, these tissues should not be treated as if they were fragile structures but rather as though they were the kind that demands energetic, even rough manipulation. This induces more active capillary loops to form and finally a vigorous and increasing blood sup-

ply, which always results in a type of repair that more nearly approaches the previous normal one.

Another important factor in obtaining this type of successful repair is the pattern of the cautery knife that is used to prepare the field for the skin grafts. This cannot be done with the usual type of small platinum cautery blade that is commonly employed. The temperature in this instrument cannot be easily regulated. It is usually too hot when it enters the tissues and cools too quickly when at work. What is required in a hot knife is a constant volume of heat that is supplied with a minimum of fluctuation. A knife that remains loaded with the necessary degree of heat regardless of how wet the tissues may be in which it is working is not only the desirable but also the necessary requirement.

This kind of a knife when it is made to circumvent the area ruined by the radio-active substance will leave in its wake tissues that will respond easily to the normal healing efforts of Nature, if it is aided by the increasingly active manipulation which I have just outlined.

About radium burns,—some months ago it was my privilege, through the courtesy of Dr. Soiland, to treat a woman in whom radium emanations had been buried to destroy a urethral caruncle. In addition, a radium pack had been applied to the vulva. The treatment had been given at another clinic and the patient consulted Dr. Soiland about the resulting ulcers, one of which had partially destroyed the distal left lateral half of the urethra, the other involving an area the size of a silver dollar over the left labia majora. This woman stated that she had been unable to lie down with any comfort for four months and could rest only occasionally when in a semi-recumbent position. Her face was the picture of misery from chronic suffering. She had been treated by the genuine ultraviolet light by the previous physician. I say genuine because, as many of you know, there is a difference in these rays as furnished by the various lamps that are on the market. She claimed that treatment had given her no relief, and, with Dr. Fouts, I may say that this has been my experience. I explained to her that I could cut the ulcerating areas out with my cautery knife and that this would relieve her pain, but that I might more or less permanently ruin the sphincter control of her bladder.

It is well to have a complete understanding with these sufferers as to what they and you are up against in trying to repair the damage they have received before you treat them. The patient is under obligations to you when you attempt to relieve him of the consequences of a radium burn. In all of my cases of malignancy I have a distinct and clear understanding with the patients that if I open the bladder or rectum in my efforts to destroy the disease that is certain to put an end to them if untreated, I will not submit to being blamed for it, and I give them twenty-four hours to think it over and decide what they will stand for. I also have the family understand the exact situation, and this should also be our attitude when we are asked to treat a radium or X-ray burn.

In the case of this woman, I dissected out the whole telangiectatic area, which included practically the whole of the left labia, major and minor, together with the ulcer of the urethra. I did this with my cautery knife because the heat in this blade can be regulated and it has back of it always a sufficient current of electricity to maintain the required stable heat in the cutting blade. This stability is not possible in the small platinum pointed knives that are on the market. They either cut too quickly or too slowly and this means that the heat penetration (the essential thing) cannot well be regulated. The first words

this woman uttered on coming out of the anæsthetic were, "My pain is gone."

For some weeks she suffered from a partial incontinence, but has now regained practically normal control of the bladder.

The important thing in the treatment of these cases is to dissect out with the cautery, all structures that are fixed with the disease, whether it is a burn from some radio-active agent or carcinoma. If you do not make the tissues that are normally movable, movable again you have not attained heat penetration to the degree necessary to destroy your pathology. After granulations have started the persistent and vigorous use of massage to encourage epithelization is most important.

The treatment just outlined is the most promising that I know of to overcome the often direful results following the destructive effects of radio-active agents. The first patient of this character that I treated was in 1917. Some one had promised an old man that his enlarged prostate could be cured with the X-ray. When I first saw him he had lost all of the skin and fat from below the umbilicus, together with that of the upper half of the penis and scrotum. The denuded area extended bilaterally to within half an inch of the anterior superior spine of the ilium. The part of the ulcerated area, especially the fascia, had the appearance of bobbed veal. There were a number of deep transverse sulci which were brownish red in color and ulcerated. They had much the appearance that one frequently sees in cancer of the labia in old women. Before I saw this patient he had consulted the late Dr. John B. Murphy, who told the family that he knew of nothing that offered any chance of healing the wound. I dissected out the involved tissue with the cautery knife, as was done in the previous case, following it with massage as soon as the granulations were sufficiently in evidence, and the result was a final and complete repair. True, the patient does not have a very handsome looking lower abdomen but, I repeat, he is cured.

Dr. Lloyd M. Otis, Celina, Ohio: I think that if just prior to the removal of the area, several weeks of high frequency is given you will have enough vascularization to help the healing sufficiently to make it worth while. This has been my experience in such cases.

The enormous vascularization produced by high frequency was brought to my attention after operating on various portions of the body where this current had been used. Hæmostasis in the operative field is many times almost impossible.

Dr. Lars Edling, Lund, Sweden: I wish to speak of the method developed by a doctor of Copenhagen, who, following the observation that dogs are always licking their wounds when they have any and that it seemed to cause a decrease in the pain, made extracts of the salivary glands and tried to treat ulcers with them and found improvement in many cases. These experiments were good and he devised a method of treating the X-ray ulcers with such extracts. I have tried the Incitamin method in many cases and can tell you that they will often respond very well to this treatment. These extracts are to be applied to the area and a rubber dam bandaged over it, which is to be changed two or three times a day. The surrounding skin should be treated with ointment for the purpose of protecting it. Usually after having applied these bandages for two or three days the pain will decrease and the patients will declare that they are very much better. It has been my experience that at the end of several weeks the ulcers will begin to have a better appearance. The saliva will decrease the pain and the process of healing will be more rapid

than under other methods, but this method is not to be used in acute ulcers. During the first acute period of the ulceration I think these extracts would not be of benefit.

Dr. I. S. Trostler, Chicago, Illinois: I would like to ask Dr. Percy if the patient who was burned in the treatment of the prostate was not treated by a technician and not by a physician.

Dr. James F. Percy, Los Angeles, California (replying to Dr. Trostler): You put me in a rather difficult position. First, because the doctor was one of my colleagues; second, he was a physician, and, third, he never was anything more than a technician.

Dr. L. K. Poyntz, Portland, Oregon: Dr. Edling's mention of the treatment of ulcer following irradiation recalls to me a method of treatment that has been used on the Continent for a considerable time and with tolerable success. The ulcer is covered with straps of zinc oxid plaster in such a manner that the secretions are retained. While at first glance this appears to be absolutely contrary to established surgical principles, nevertheless the results appear to justify the procedure and, after all, results should be the final criterion. These straps are retained in position for several days, usually four or five, when the dammed-up secretions cause some discomfort by pressure and may even be malodorous. They are removed and replaced by fresh strapping, which must be zinc oxid. This method has been used in the British army for old indolent ulcers of a different nature and the results are good. Dr. Imboden recently had a most wonderful result in the case of an X-ray burn by this method. It appears that there is some digestive property as well as the bactericidal characters in the secretion.

I would like to hear an expression of Dr. Schmitz's opinion on the efficacy of the mercury vapor lamp as a prophylactic precaution in cases that are to receive intensive irradiation.

On the subject of delayed effects of raying,—those of you who have had the opportunity to see the long series of cases Prof. Halbestadter has collected must have been impressed at the long latent period which does sometimes occur before necrosis begins. He has an unusual collection, showing ulcers beginning as long as twelve years after treatment with no evidence of trouble in the interval. These make one just hesitate and wonder what to expect in one's own work in the matter of a few years.

Dr. Henry Schmitz, Chicago, Illinois (closing): Dr. Edling refers to the use of the digestive ferments, especially Incitamin. We have used it extensively. At times we find a case that will respond to its use; at other times we find that pepsin or pancreatin seem to do well, but none of them is a specific. The X-ray and radium ulcers are indurations due to endarteritis and fibrosis. If we intend to perform surgical eradication with a cautery or a knife, we must operate in healthy tissue so that the repair may come from healthy tissue.

I wish to call your attention particularly to the repeated X-ray or radium applications. They are the most frequent causes of latent ulcers. If the injuries do occur we should practice conservatism in treatment. If we can excise all of the diseased tissue, surgery always would be indicated. But if we cannot excise all the tissue, the treatment must be expectant.

Discussion on Paper of Dr. Amedee Granger[1]

Dr. Frederick H. Rodenbaugh, San Francisco, California: We have been following a technique advocated by Dr. Van Zwaluwenberg which we

[1]Paper printed in Radiology, Sept., 1923, p. 6.

found added considerably to our sphenoid technique. I have not had personal experience with Dr. Granger's method, but feel sure that we are all missing sphenoid cases with the present technique.

DR. LARS EDLING, Lund, Sweden: I wish to say just a few words about the technique which Dr. Granger has shown us and will tell you that in Sweden we have used much the same technique. I think it must be about the same angle from before backward as he has shown, both in the examination of the frontal and sphenoid sinuses. We have found that this technique gives us a very good picture of the sphenoid as well as of the maxillary sinuses, and we use this method in the antero-posterior direction as well as in the lateral position in making the diagnosis in sphenoid disease as well as in maxillary lesions and disease of the other sinuses. I am of the personal opinion that this technique will ever be the best, whether you use stereoscopic pictures or not.

DR. JOSEPH ASPRAY, Spokane, Washington: During the last two years I have been using a technique which arrives at similar results for the posterior ethmoid and sphenoid sinuses. However, I have been getting it in a different way. Instead of using the block with 23 degree angle we lay the patient's head on the table, in the usual frontal position, and project the ray upward instead of downward. This produces much the same radiograph as we have seen projected on the screen, but the angle of the ray is focused in the central portion of the foramen magnum and obliquely upward for 10 degrees. I have some slides that will show this angle and the method. (Exhibited series of slides.)

We have also been using a modification of Pfahler's method for the sphenoid, using a small aluminum set which goes in the mouth in much the same way as Pfahler's does but in a different position. We place the patient on his back on a four-inch hard pillow and project the ray down through the head at a 90 degree angle and have the ray projected down towards the mouth, the edge of a 3-inch cone being on a line with the anterior portion of the frontals.

DR. AMEDEE GRANGER, New Orleans, Louisiana (closing): I would like to have Dr. Edling tell us whether he used a head rest having a hole cut out for the nose.

DR. EDLING: No, we did not.

DR. GRANGER: In that case the position employed by the doctor is not the one which I used, although his angle is probably the same. This new position, the *Alveolar-glabella,* is much more important than the angle in which the head is placed or the angle which the central ray forms with the negative, because it is only by its use that it is possible to make identical skiagraphs of the same head or skull and very similar looking skiagraphs of different heads or skulls at will.

I have fully demonstrated this by making ten to fifteen skiagraphs of the same skull that were exact duplicates, and by making strikingly similar looking skiagraphs of the skulls of a white woman, a white man and a negro man, even though these skulls varied greatly in shape, size, and craniometric measurements.

In order to place the head in this position it is absolutely necessary to make use of a head rest with an aperture cut out to receive the nose. This applies also to dried skulls, because their nasal bones will prevent the alveolar point and the glabella from being in contact with any plane surface at one and the same time.

This head rest consists of a sheet of bakelite with an aperture cut out, attached to a frame. The purpose of this frame is to hold the bakelite sheet se-

curely over a cassette and at the same time keep it about one-half inch away. When the nose is placed in the aperture of the head rest, the head becomes automatically centered over the same part of the film, the soft tissues of the nose are compressed without pain or discomfort, and the head can be made to rest on the alveolar point and the glabella. These two points, which bear a very constant relation to each other even in heads of different shape and size, now afford a good and firm support for the head, doing away entirely with the tendency to pivot either in the direction of its longitudinal or transverse diameters, which is always present when the nose is one of the points on which the head rests.

The skiagraphs of the skull exhibited by Dr. Aspray are splendid and most interesting, and I would judge that we are both using about the same angle. I must call your attention to the fact that although these skiagraphs were made of the same skull and at the same angle they are not exact duplicates. This is to me still another proof that constant uniformity in results can be obtained in sinus work only if the *Alveolar-glabella* position is used.

Furthermore, I am certain that it is a mistake to study the sphenoid sinus without at the same time studying the ethmoid cells, which lie practically in the same plane and which bear such a close anatomical and clinical relation to it. When the sphenoid sinus alone is filled with opaque material, the large, distinct shadow which it produces on the negative leads to the erroneous conclusion that it can be just as readily recognized on negatives of heads, and that any opacity in that region must result from some pathology of the sphenoid sinus. But my work with several skulls in which the sphenoid sinus and the two groups of ethmoid cells were filled with different opaque substances showed that the shadows of the sphenoid sinus and the ethmoid cells were merged to a very great extent, no matter what the angle and position at which the negatives were made, and that by using the position and angles described in this paper these shadows could be dissociated to the greatest extent and sufficiently to make their identification clear and positive.

I do not hesitate to tell you that the otolaryngologists of New Orleans, and I believe of the entire country, were, to put it mildly, much disappointed with the roentgen examination of the sphenoid sinus, and had about reached the conclusion that it was quite worthless in the diagnosis of disease of this sinus. Their attitude has entirely changed since I have been able to point out to them constant and definite landmarks, and to show them alterations in *the curved line* which forms the upper boundary of the sphenoid and in the space which lies immediately below it, and, more especially, since I have been able to correctly interpret these changes in terms of definite pathology.

Discussion on Paper of Dr. Arthur W. Erskine[1]

Dr. Henry J. Ullmann, Santa Barbara, California: It is rather difficult to add anything to so extensive a piece of work as this. The briefness of the paper does not do justice to the amount of work required to get the measurements. A study of the charts which Dr. Erskine has in the exhibit room is well worth while by any one who is interested.

I can think only of one point which might be of value. We are, most of us, I think, using fractions of a millimeter of copper, one-half, three-fourths or one millimeter of copper plus a millimeter of aluminum. At Santa Barbara we started to make some observations with these particular factors, using the Solomon Ionometer and a paraffin block

[1]Paper printed in Radiology, Sept., 1923, p. 10.

instead of the water phantom. With a port of 18 cms. we found that with one millimeter of copper plus one of aluminum the amount of radiation received at 10 cm. depth was 55 per cent of that at the surface of the paraffin, with 0.5 it was 50 per cent, and with one-fourth it was 21 per cent. If we think in terms of radiation absorbed, which is the radiation that does the work, we can think of 45 per cent absorbed in the first ten centimeters of paraffin with one millimeter of copper, 50 per cent absorbed using one-half millimeter of copper, and 79 per cent absorbed using one-fourth millimeter.

Looking at it from another angle, 10 per cent more is absorbed with one-half than with one millimeter, 38 per cent more with one than with one-half, and 43½ per cent more with one-fourth than with one millimeter of copper.

We also observed that the intensities at the surface with these three thicknesses of copper were in relationship of one to one and one-half and two. If the intensity with one millimeter of copper was one, with one-half millimeter it was one and a half, and with one-fourth millimeter it was two. There was always one millimeter of aluminum used in addition.

What value is this in actual work? If we have a patient not over 20 cm. thick and the lesion is 10 centimeters deep, we do not need to use a whole millimeter. If we use one-half we get the full dose at that depth when radiating from two ports and get it in two-thirds the time. If the lesion is within the first five centimeters of depth or near the surface we do not have to send most of that radiation through the patient to be absorbed at a greater depth; if we use one-fourth millimeter of copper we will have it absorbed near the surface, where we want it, and will cut our time down one-half. I think it will help us to think in terms of absorption rather than in terms of penetration.

PROFESSOR D. L. WEBSTER, Leland Stanford University, California: As a physicist I cannot speak much on the medical end of this question but should like to add a word on the importance of measurements of this sort and the advantage of this method over that of Dessauer. In this method, measurements are made by the ionization chamber and in the Dessauer method, by photographs. It looks easy to measure the photographic plate and get a good idea of the intensity, but practically, the calculation of intensity from the blackening of a plate is difficult, and the photographic method should be used only as a last resort. I think we should congratulate Dr. Erskine on having used the most accurate method.

DISCUSSION ON PAPER OF DR. H. J. ULLMANN[1]

DR. ALBERT SOILAND, Los Angeles, California: This is one of the best papers I have ever listened to on common-sense therapy. There is no exact dose or erythema dose that is at all stabilized and no cancer dose that will cure all cancers. Dr. Ullmann has said that we must treat the individual in order to cure the disease. The question of the wave length and dosage is something which we know nothing about at present. We can give the so-called "suberythema" dose to one individual and apply the same dose to the next individual and get two distinctly different therapeutic responses. We could spend a good deal of time in taking up the subject of radiation, but I do not believe we are justified in talking about a shorter wave length. I am fully convinced that we have sufficient wave length to do more harm than good. We have not learned the strength of the short wave length. That has not been worked out pathologically. With the question of delayed reactions which are becoming apparent daily and when we see patients three

[1]Paper printed in Radiology, Sept., 1923, p. 31.

and five years after treatment developing necrotic areas, we have to stop and think. We hope that it is due to the wave length and that with the new short wave length we will not get such results, but we do not yet know this. I think we have to standardize our wave length and we have to standardize our patients and try to give sufficient radiation to cure the tumor but not to interfere with the physiologic reactions of the human body.

Dr. Frank S. Bourns, Seattle, Washington: I wish to express my great appreciation of the paper just read. Isolated in the extreme northwest part of the country, I go through many periods of mental distress because of the lack of satisfaction in some of the results we get. I have been using the new machine for about fourteen months on a considerable number of patients and this idea has been getting stronger and stronger in my mind, that we are not going to cure all cases by simply giving the regulation cancer dose in each of them. If we do not have the co-operation of the internist we will not do much better in the future than at present. If we do have this co-operation we will get better results. At a meeting of the State Medical Association this matter was brought up and discussed. We all had had experience with smaller doses in the past, before we got the big machine, and we know that sometimes good results were obtained.

I have been trying out the so-called fractional dosage in a case of carcinoma of the liver, verified by the pathologist, where I felt certain that a large dose would hasten the end rather than prolong life and obtained very striking temporary results. The patient has received a series of three treatments, with a period of rest and another series of three treatments, and the results have been very striking.

The paper of Dr. Ullmann is one of the most satisfactory that I have heard for a long time. I think those who are fortunate enough to be placed in connection with laboratory facilities should keep their records so that those who are not can have the benefit of the work and results.

Dr. H. H. Bowing, Rochester, Minnesota: I am more than pleased to hear Dr. Ullmann's favorable comments on the fractional dose method and individual treatment. The rapid healing which usually occurs in carcinoma of the cervix uteri to a fourteen-hour application of a fifty milligram tube is astonishing. A repetition of this treatment about twice a week does not cause ulceration nor any inflammatory reaction in the part; instead, we see a gradual diminution in the tumor, its gradual absorption, and a return of the tissues to normal appearance. The patient's general condition improves almost as rapidly, and in this way affords the best possible chance for his recovery. In other words, you have brought the two factors into play; that is, sufficient radium has been employed to bring about local healing as well as stimulation of those factors so essential in returning the patient to good health. The broken-dose method furnishes the widest range possible for individual treatment. I have had many experiences which have led me to believe that the broken-dose method is the one of choice. It is possible that this would not work out in a large majority of patients and that this result in a way was sufficient for the patient in question. It is to be regretted that we are not able to determine this when the treatment is outlined. As a rule, these patients are greatly demoralized before the treatment and severe treatment reactions usually will only add to their discomfort and they will soon express themselves to the effect that they feel sure that they cannot stand any more

treatment and dread the next application, whereas if the applications are not too long and the interval between sufficient, their general condition as well as the local one will be so improved that they will be anxious for the next treatment to come.

Cancer has never appeared to me as one of infection and the terminology usually used in discussing infection does not seem to apply.

Carcinoma cells are comparable in many respects to ordinary tissue cells of the body with the exception that they are devoid of function. All animal experimentation has not shown in any way an immunity reaction.

Dr. MacCarty has shown in his study of untreated cases of breast carcinoma and gastric carcinoma that there are certain defense factors present, and he speaks of them as differentiation, round-cell infiltration, hyalinization and fibrosis. It is possible with radium applications to bring about reactions in the tissue comparable to these, although it is essential that we do not over-stimulate a fibrotic change and, therefore, if the milligram hours have been accurate there should not be an over-production of fibrous tissue. In other words, we have a method of treatment at our disposal which will bring about a change that stimulates the characteristic tissue reactions employed by the body to overcome the new growth.

Dr. Wesley H. Wallace, Brooklyn, N. Y.: I feel that I have been amply repaid for my trip by hearing this paper. I felt that I was a lone lamb among wolves for this is the first time that I have ever heard any one say in public that they did not know what the erythema dose of X-ray was. I have said this for years and have made the statement on the witness stand that no one can tell the proper dose for all cases. What might be right for one patient another could not take at all. Everybody knows this is true, but they do not say so.

I think it might be well to add to the other specialists Dr. Ullmann mentioned the psychiatrist, not for the benefit of the patient but for that of the doctor.

Dr. Henry J. Ullmann, Santa Barbara, California (closing): I think we must revise our ideas of the effect on the skin when we use copper radiation. I will give as an example a case of carcinoma of the face, dosage factors 200 KVP. 0.25 mm. cu. + 1 mm. Al. 40 cm., f.s.d., 150 milliampere minutes. After an interval of four weeks, as little or no reaction occurred, the other factors being the same, 280 milliampere minutes at 44 cm. f.s.d. were given over an area 7 cm. square. This brought about a sharp reaction with œdema, but in spite of the fact that the patient was warned that there would be no regrowth of hair, in four months there has been a good regrowth of hair. I have yet to see a case in which copper screening was used where the hair would not regrow in nine months to a year. Perhaps the hair will fall out later but this is the experience we have had in fourteen months' work with the big machine.

Dr. Bowing spoke of the reaction of the patients. It seems to me that in the non-malignant cases we can individualize very strongly. Take, for example, a case of fibroids where myomectomy is not to be done. If you apply radium in a large dose you will naturally affect the ovaries. Therefore, use radium in a smaller dose and then, after a few months, if the fibroids have not been reduced sufficiently apply it again. If you will stop to think of the great difference in distance from the radium existing between the ovary and the myoma, you will realize that the ovary has a much better chance to recover from a given dose of radium than the myoma. Therefore, it should be possible to so

space dosage that the myoma is permanently affected while the ovary is not. I refer to the effect on menstruation. I do not know whether pregnancy can occur but, with a properly fractionated dose, reduction of the tumor may be obtained without producing the menopause.

The "immunity" is the kind referred to by Maude Slye of Chicago when she stated that certain individuals among the mice with which she has worked will not take tumor grafts, while in certain others the grafts will take. When I spoke of Russ's experiments on rats I used the word "immunity" as meaning that, in certain of the rats, the cancer did not grow so fast. That article is well worth reading by any one who is interested in this subject. We know that certain individuals do not take cancer grafts well. If "immunity" is not a good term to describe this, let us invent another,—I would rather use "reaction to cancer."

In regard to measurements, I am glad most of us are getting away from the erythema dose. There is no such animal,—it is too variable. There may be a 300 per cent variation in different individuals. But we can measure the physical factors. We give ¼ or ½ grain (the physical factor) of morphin, for instance, to an adult, but we do not give this dose to the child. The dose must be adjusted to the individual. In speaking of the dose that will produce immunity or reaction I mean the production of a dose that will be an optimum dose. What do I mean? The dose that, first, will produce the maximum curative effect on the tumor cells; second, at the same time produce a reaction against those cells by the body, and, third, the least injury to the individual. By the optimum dose I mean those three things.

DR. CLAY EMERY GIFFIN

Members of the Radiological Society will be grieved to know of the loss from their ranks of Dr. Clay Emery Giffin of Boulder, Colorado. It seems unusually sad to have one of our brother members cut off at the age of 41 years from the midst of work which seemed more than hopeful but uncompleted. Just as he must sacrifice the pleasure of providing for and directing his young children to maturity so must his family and our science sacrifice the blessings his life would have given them.

Dr. Giffin died as he had always lived, for others. The incidents of his death are extremely pathetic. He had arranged an outing for his family in the mountains. His wife and he were preparing a picnic lunch on the banks of the Boulder River and his thirteen-year-old son was wading in the river when suddenly the doctor saw his son stumble and fall, being immediately swept out into the swift current of the stream. The father, realizing his son's danger, instantly plunged to his assistance with the tragic result that he gave his life to save his son.

Dr. Giffin enjoyed the distinction of graduating from the Colorado School of Medicine while his father was Dean of that institution. His short career was marked by rapid progress, he having been president of his local medical society, chief of the staff of the Community and an officer in other organizations.

It is a cause of universal regret that Dr. Giffin should have been taken at the very pinnacle of his greatest usefulness to his family and to the science of Radiology.

EDITORIAL

M. J. Hubeny, M.D. . . . . *Editor*
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Benjamin H. Orndoff, M.D. }

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The American College of Radiology

For a great many years, the writer has felt that radiology as a science has not received the recognition from the medical profession that its achievements warranted. On former occasions, he talked with prominent radiologists, and broached the idea of a College of Radiology. Deciding to make a canvass, he selected seventy-five men in the United States with whom he was personally acquainted, men who were making history in radiology. He asked these men their opinion as to the advisability of instituting such a college. He received in round numbers sixty favorable answers.

The idea of this college was not to place a wreath upon the brows of the older men, or to set them aside as supermen; the writer felt that men who had conscientiously and honestly striven to make radiology a respected and useful branch of general medicine were capable of directing future work of this specialty and laying out a course which the younger members could safely follow. He realizes that probably twice the number called upon are just as eligible to be members as the first list interrogated. He also wants to state that if some feel that they have been overlooked or slighted, such is not the intention or spirit of this organization, but a beginning has to be made and a nucleus formed, around which can be built up the sort of college which will meet the requirements of all those eligible. Therefore, when this gratifying response to the first communication was received, a meeting was called during the San Francisco session of the American Medical Association, and the temporary organization perfected.

(Signed) Albert Soiland, M.D.

Editor's comment: The need for the American College of Radiology is pertinent, comparable to the same motives and objects actuating the formation of the American College of Surgeons and the American College of Physicians. This Society infringes in no way on any other organization, it will afford encouragement to the young men entering this comprehensive, exhaustive, and very valuable specialty.

A glance at the list of officers named on page 124 of this issue will impress one with the solidity of the organization, assuring its usefulness and success.

Protective Insurance

A prominent company issuing medical protection, enacted the following policy which became effective May 28, 1923:

"Applications for a Medical Protective contract will not be acceptable from any person who is not a regularly licensed physician or dentist.

"This includes radiographers, technicians or any other person whatsoever who is not a regularly licensed physician or dentist.

"This ruling also includes applications for institutional coverage such as hospitals, laboratories or any other professional organization that is conducted by any person who is not a regularly licensed physician or dentist.

"This ruling also eliminates the inclu-

sion in a blanket policy with regular practitioners, of any person who is not a regularly licensed physician or dentist."

The above policy is far-reaching in its effects; it will insure the patient receiving qualified professional service in a specialty that is oftentimes misapplied and abused, because it has been the habit of certain institutions to employ undrilled, unschooled, and incompetent lay persons to use X-ray and radium.

TRANSPORTATION TO ROCHESTER

Anticipating the largest conclave of roentgenologists ever assembled, your attention is called to an important announcement on another page of this issue, concerning the transportation rates to members and their families. Be sure to read this, so that you may benefit thereby.

Also, it would be well to make hotel reservations in Rochester well in advance of the date of the meeting.

GENERAL INTEREST

MILES BRONSON TITTERINGTON, M.D.

Dr. Titterington, the second president and one of the founders of our Society, has passed into the great undiscovered country, "like one who wrapped the drapery of his couch about him and lay down to pleasant dreams." His passing is keenly felt in the realm of radiology. Unassuming, quiet, ever ready to give or take a good joke, always gravitating toward that spot where the most difficult work was to be done, "T" is missed more and more as time goes on.

Unlike many of his colleagues, Dr. Titterington did not intend to make the practice of radiology his life work, but was gradually pressed into that sphere of endeavor by the excellence of his work and the demand for his services, by his fellow practitioners. As time went on, Dr. Titterington was forced to give more and more of his energies to X-ray work, until he finally arrived at the decision to take over the unfinished work of Dr. Carman, who had been called to Rochester, Minnesota. He thereupon removed his residence and office to St. Louis, where he won an enviable reputation as a radiologist.

About two and a half years ago Dr. Titterington was forced to rest from his work for a short period. Thanks to the value of a well-spent life, his recovery was prompt, and ere long he was back at his work. Later a ruptured appendix laid the foundation for a chest infection and he did not have the reserve force to meet the enemy, so he died as he had lived, quietly and without fear of the hereafter.

As one of the "fathers" of the Radiological Society, "T" (as was his favorite nickname) never missed a meeting, and was ever upon the alert to make the Society bigger and better. In event money was needed to further a project, his hand never came empty from his pocket, and he gave as much as his resources permitted.

His contributions to the literature of the X-ray world were ever of the "few notes" type. Brief almost to brusqueness, he never made use of two words in composition where one could be made to answer.

Providence was kind in endowing him with a son, Paul B. Titterington, M.D., who has finished his medical schooling, and has assumed the unfinished work of his father.

It has been the sad duty of the Radiological Society to give to Mrs. M. B. Titterington and her son Paul, a bronze

shield, which has been photographed for reproduction herewith. "If you have a flower to give, give it to-day—to-morrow may be too late." The lament of his most intimate friends is that he could not have heard and enjoyed during his lifetime, the words that are spoken now of him.

At a meeting called during the San Francisco session of the American Medical Association in June, organization was perfected for an American College of Radiology and the following officers were elected:

President, Dr. George E. Pfahler, Philadelphia.

President-elect, Dr. William H. Stewart, New York City.

Vice-president, Dr. Henry Schmitz, Chicago.

Executive Secy., Dr. Albert Soiland, Los Angeles.

Treasurer, Dr. Benjamin H. Orndoff, Chicago.

Historian, Dr. I. S. Trostler, Chicago.

Board of Chancellors

Dr. R. D. Carman, Rochester.
Dr. L. T. Le Wald, New York City.
Dr. B. H. Orndoff, Chicago.
Dr. W. W. Wasson, Denver.
Dr. Amedee Granger, New Orleans.
Dr. G. E. Richards, Toronto, Canada.
Dr. W. W. Watkins, Phoenix.
Dr. Arial George, Boston.
Dr. Lloyd Bryan, San Francisco.
Dr. Edwin Ernst, St. Louis.

TRANSPORTATION TO ROCHESTER

The attention of all who expect to attend the meeting of the Radiological Society at Rochester, Minn., Dec. 3 to 7, 1923, is called to the following:

A rate of one and one-half fare for the round trip, on the certificate plan, will apply. This rate will also apply to the members' families or those attending the meeting, and will hold good from anywhere in the United States and Canada. Children of 5 to 12 years when accompanied by parent will be charged half fare.

THE FOLLOWING DIRECTIONS ARE SUBMITTED FOR YOUR GUIDANCE

1. Tickets at the regular one way fare for the going journey may be purchased Nov. 28 to Dec. 5 (but not on other dates). *Be sure that you ask for a certificate when buying going tickets. Do not make the mistake of asking for a receipt; YOU WANT A CERTIFICATE!*

2. Present yourself at the railroad ticket office or station for tickets and *certificates* at least 30 minutes before the time for the departure of your train.

3. *Certificates* are not kept at all stations. If you inquire at your home station, you can ascertain whether *certificates* and through tickets can be obtained to Rochester, Minn. If not obtainable at your home station, the agent will inform you at what station they may be obtained. You can in this case purchase local ticket to the station that has *certificates* in stock, and there purchase through ticket and secure *certificate.*

4. *Immediately on your arrival at the meeting present your Certificate at my desk at the registration office* of the meeting. The reduced fares for the return journey will not apply unless you are properly identified as provided for by the certificates. It will be necessary that my name appear upon your certificate so that the joint agent of the railroads will validate the certificates.

5. There will be a special joint agent of the railroads at the meeting place Dec. 4 to 7 to validate the certificates. *Your certificate must be validated or you will be unable to secure the half fare rate for the return ticket. If validated you will be able to buy return ticket to the point where you received the certificate at half fare.*

6. It must be understood that the reduction on the return fare is contingent upon the attendance of not less than 250 at the meeting (from outside); but there is no doubt that this number will be exceeded by from 500 to 1000.

If the necessary 250 *certificates* are presented for validation up to and including Dec. 11th, you will be entitled to a return ticket over the route you made the going portion of the trip at one-half the regular one way fare from Rochester to the point where your *certificate* was issued.

7. Return tickets issued at the reduced fare will not be good on any limited train on which such reduced fare transportation is not honored.

8. *No refund of fare will be made on account of failure to obtain the*

proper certificate when purchasing ticket, or on account of failure to present certificate for validation or failure to present validated certificate when purchasing return ticket.

9. Those coming via Chicago will do well to get in touch with me within two weeks of the meeting so as to secure information regarding the special trains from that point to Rochester. It will be much pleasanter for a large party to travel together than for us to travel alone. Special trains will probably leave Chicago so as to arrive in time for the first session.

PRESERVE THIS NOTICE FOR FUTURE REFERENCE

I. S. TROSTLER,
Manager of Exhibits and Transportation,
25 E. Washington St., Chicago.

Dr. Alvin Kirmse, former Counselor of Arizona, and for the past year associated with Dr. Hugh Crouse of El Paso, Texas, has recently removed to his former home in Marionette, Wisconsin. This change is occasioned by the illness of his aged father.

At the last meeting of the New York Roentgen Society the following officers were elected for the ensuing year: President, Dr. F. M. Law, New York; secretary, Dr. L. T. Le Wald, New York; treasurer, Dr. John Remer, New York; member of executive committee, Dr. C. Eastmond, Brooklyn.

Hotel accommodations for the Rochester meeting. Owing to the unusually large estimated attendance, all of the best hotels in Rochester will be booked to capacity. All have agreed to hold a definite number of rooms for the occasion. Mr. Roy Watson, Assistant General Manager of the Kahler Corporation, has been appointed Secretary of the Committee on Hotels and Banquets, and members are urged to make application for reservations direct to him to avoid confusion. Cards will be mailed shortly to members for this purpose.

CHIEF X-RAY HAWK EYE

By J. WILSON SHIELS, M.D., SAN FRANCISCO

Should you ask me why I come here,
From the land of X-ray Roentgen,
I should answer, I should tell you,
I am he who deals in learning,
From the books of many writers,
Delving deep in learned questions
That are solved by X-ray effort,
In the darkness of the screen room.

In the darkness of the screen room,
Where the tribe of cunning Ray-men
Stand protected from the tube-light,
So that many papoose Ray-men
May be given to their people.

. . . . . .

Lo! the child with thymic dullness,
With his tonsils deep in trouble.
Lo! the heart that is aortic,
Beating big with strong emotion.
Lo! the vessels that are hardened
By the spirochete of ages.
Lo! the bronchus that is widened
By the loss of 'lastic tissue,
And the coughing of the chieftain
That disturbs the squaws at midnight.

. . . . . .

Lo! the holding of the midriff
In a place that is abnormal.
All of this is shown by pictures,
Clever pictures that are taken
By the wisdom of the people
Who are sitting here around me,
Glutting deep of dainty dishes,
'Till a sickness comes upon them.

Lo! the bones of auto-smashes,
Lo! the bones of railroad-crashes,
Lo! the bones of aviation,
Broke and bent in funny places;
Fractures made in simple manner,
Fractures made in compound manner,
Fractures that are comminuted,—
All are plated, yes, are plated,
In a line that is made perfect
By the picture that is taken
By the rays of Great Chief Roentgen.

Lo! the vessels in the thorax
That are known as aneurysmal
And are pressing on the gullet,
Causing mediastinitis.
Lo! the pus that gathers slowly
In the space between the lung-lobes,
Ending in a pyo-thorax.

Lo! the stomach filling fault-like,
Lo! its antrum when imperfect,
Lo! the duodenal angle,
By the flame of inflammation,
Made acute by strong adhesions,
Hinting—maybe, cystic trouble,
Hinting stone existing,—maybe,
In a bladder where the bile flow
Loses all its golden yellow,
By the venom of the strepto,
By the wily streptococcus,
Working out its baneful purpose,
Like the vapors of the moontime,
Bringing sickness to my people.

All of this is showing plainly
By the pictures that are taken
By the peaceful tribe of Roentgen,
Who are very cunning Ray-men,
Changing gold from patients' purses
From one pocket to another.

This poem was written by Dr. Shiels and recited by him at the banquet given at the Palace Hotel, San Francisco, during the mid-annual meeting of the Radiological Society of North America, in June. As the reader, if present upon that happy occasion, will recall, it contributed in no small measure to the gayety of the company assembled.

ABSTRACTS OF CURRENT LITERATURE

Bierman, M. I.: The Roentgen Rays in Thyroid Therapy. *Minn. Med.*, 1923, vi, 322.

The effects of radiation upon thyroid tumors as well as upon other neoplastic tissue formations are primarily direct, acting on the cells themselves. The rays affect the protoplasm as well as the nucleus of the cell, but the interference with the nucleus is usually of much greater significance for the function of the cell than the localized changes in the cytoplasm, as any marked interference with the nucleus results in the death of the cell.

The changes produced in the cells are attended by no risk whatever to the patient provided that the ordinary precautions peculiar to X-ray treatment are observed. It is true that the surgical removal of the thyroid will produce results much more rapidly than roentgen-ray treatment; but the uncertainty of improvement, the dangers of operation, and the advisability of first using less extreme measures of treatment will militate against operative interference in favor of radiation. Radiation is the treatment of choice in all types of toxic goiter.

The author uses an 8 or 9 inch spark gap; 3 to 6 mm. aluminum filter; cross-fire method; repeated at intervals of 2 to 3 weeks. It is not advisable to produce even a mild erythema and it is important to maintain a check on the effects of radiation by observations of the metabolic rate. When this decreases rapidly to 25 or 30 per cent below normal it is well to discontinue treatment. The changes produced by X-ray continue to exert their influence for as long as two to three months after the last treatment and if treatment were continued until the metabolic rate reached normal the final result would be a negative rate or hypothyroidism.

The treatment of thyroids by roentgen-ray is necessarily a long-drawn-out procedure extending over many months and at times even requiring two or three years for a complete cure, and the treatment is rather of benefit only in selected cases which show undoubted metabolic hyperactivity. The adenomatous and exophthalmic types are especially favorable. Other forms such as simple goiter, colloid goiter, the cystic goiter, and the goiter of adolescence are not proper subjects for roentgen-ray treatment.

Mann, A. T.: Diaphragmatic Hernia. *Minn. Med.*, 1923, vi, 285.

In the past diaphragmatic hernia has rarely been diagnosed before operation. During the last ten years with the use of the X-ray, occasional cases here and there have been made

out before operation and such diagnoses are becoming less uncommon. The X-ray is a great aid; with it one should be able to diagnose nearly every case. However, the attention of the diagnostician must be caught by some feature in each case which calls for roentgen examination or it may not be used and many cases will still be missed. The clinical diagnosis is no clearer than it was before.

The author describes two personal cases in which the diagnosis of diaphragmatic hernia was rendered evident by the X-ray examination and verified by operation. In the second case the roentgenograms showed a large portion of the stomach and some of the ileum and large bowel above the diaphragm; the entire splenic flexure was seen in the thoracic cavity.

Singer, J. J., and Graham, E. A.: Abscess of the Lung. *Jour. Amer. Med. Assn.*, 1923, lxxxi, 193.

The authors say that roentgen-ray findings in abscess of the lung are usually typical, provided the abscess is large. Dense (homogeneous) shadows are seen with fairly good lung tissue around the lesion. The borders are not so sharply demarcated as in tumor of the lung. The costophrenic angles are usually clear, unless there is an associated pleural effusion. The apexes are also usually clear. In the fluoroscopic examination one can usually see a dense shadow around the hilum toward the periphery. If the patient is examined tangentially, the lung abscess shows a more definite shadow. Plates of the patients should be taken serially. Occasionally a fluid level is seen in the shadow and when found is a pathognomonic sign of cavity.

Lemon, W. S.: The Status of Present-day Methods of Examination in the Diagnosis of Intestinal Tuberculosis. *Minn. Med.*, 1923, vi, 300.

The diagnosis of intestinal tuberculosis is made on circumstantial evidence collected from the history of the ailment, the examination of the patient, laboratory data, which include definite and accurate observations of the roentgenologist, and the microscopic examination of removed tissue.

Undoubtedly the roentgenologic examination is the most precise method at our disposal and probably will demonstrate lesions before any other. Yet Carman finds that interpretation is not without difficulty because there are no pathognomonic roentgen signs. The filling defect and the absence of the normal barium shadow in the cæcocolon are signs of any ulcerative lesion. If, however, the patient is being examined with the thought of his tuberculosis always in mind, such findings take on the certainty of diagnosis. There is a definite predilection for the ileocæcal coil and a lesion here is always suspected to be tuberculous when the patient has not reached cancer age and the more so if he has either active or latent pulmonary disease. Fully 85 per cent of all cases of intestinal tuberculosis are found in the ileocæcal area.

Firth, D., and Playfair, K.: Congenital Idiopathic Dilatation of the Colon. *Arch. of Radiol. and Electrother.*, 1923, xxvii, 321.

The case described by the authors in a boy aged 10 years, differs in no way from the general picture of Hirschsprung's disease, but, as far as they know, a similar series of radiograms has not been published. These radiograms show the gradual filling of the dilated intestine leading to angulation of the sigmoid, and the falling over from one side to the other of the dilated colon, suggesting why volvulus is a frequent complication. After administration of a bismuth meal, X-ray observations were made at intervals for twelve days, during which time the bowels were never opened. No abnormality of the stomach or small intestine was detected. The sigmoid and colon contained bismuth within 24 hours. The sigmoid and colon became more distended, and later the descending and transverse colon, with a definite kink between the sigmoid and descending colon. Throughout this time the boy remained well, and the bowels were opened at the conclusion of the observations by enemata followed later by daily motions under pituitrin hypodermically. The condition being improved, a further course of bismuth was given and radiograms taken over a period of 22 days, during which time no action of the bowels took place. The abdomen became greatly distended, enlarging to 25 inches in circumference, and as at this stage the boy began to show discomfort the bowels were freely evacuated by enemata.

The boy has a sharp angular scoliosis due to a congenital maldevelopment of the left half of the body of the tenth dorsal vertebra. The association of congenital idiopathic dilatation of the colon with the defect in the osseous system is interesting. It is a well known fact that congenital defects of the central nervous system are frequently associated with deformation of the skeletal system. Possibly the dilatation of the colon may have been related to some imperfection in the development of the splanchnic nerves given off at the level of the half vertebra.

A series of ten radiograms accompanies the text.